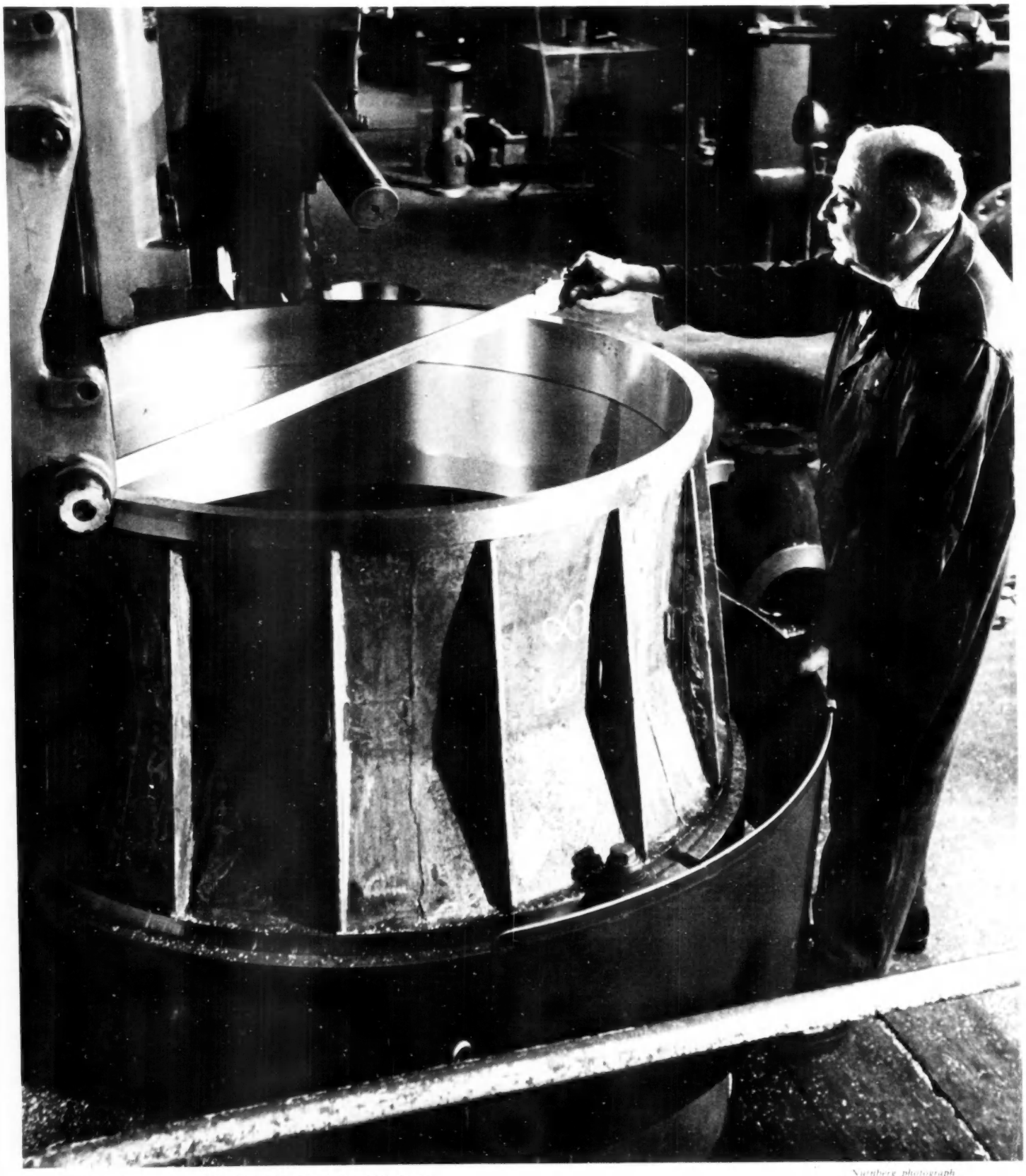
ENGINEERING

An Illustrated Weekly Journal

35 & 36 BEDFORD STREET, STRAND, LONDON, W.C.2 - - TELEPHONE: TEMPLE BAR 3663

Vol. 184 No. 4783 *LONDON, FRIDAY, NOVEMBER* 8, 1957 PRICE 2s.



CHECKING ACCURACY OF MACHINING

Nurnberg photograph for ENGINEERING

NOVEMBER 8, 1957 VOL. 184 PAGES 577-608

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Published every Friday by Engineering Limited, 35 & 36 Bedford-street, London, W.C.2.
TELEPHONE: *Temple Bar* 3663. TELEGRAPHIC ADDRESS: *Engineering Lesquare London.*
Subscription Rates: 12 *months, Inland and Abroad* £5 10*s.*, *Canada* £5 5*s.*; 3 *months,* 27*s.* 6*d.* *all countries. Single copies,* 2*s.* 7*d.*, *post free.*

THE SPENDING FAMILY

It is a commonplace to say that over the last 20 years, despite a major war, the standard of living has increased for the average man. It is true that the professional classes tend to be worse off than some salaried and most wage-earning employees but the general picture is one of people having more money to spend.

Once in a while a document is published which brings to notice quite abruptly that changes have taken place gradually and that they have brought about a silent revolution in peoples' attitudes without our being fully aware of it. Such an occasion is the publication by the Ministry of Labour and National Service of the *Report of an Enquiry into Household Expenditure in 1953-54*. This report brings together a great deal of information on spending habits throughout the country in connection with the revision of the cost of living index. Over 13,000 households co-operated in the inquiry and they represented about 41,000 people of whom nearly 30,000 were over 16 years of age.

It is important to appreciate the background against which these households, for a period of three weeks, maintained detailed expenditure records in co-operation with the Ministry of Labour. The exercise took place after 15 years of full employment and a significant increase in the standard of living in the second half of that period. The gains to the households concerned owed something—in many cases a great deal—to the redistribution of income through taxation, but much of their increased prosperity came from a genuine increase in the national income. Towards that increase, the engineering industry has made a vital contribution. If it had not been for inflationary forces attracting labour into other industries the contribution from engineering might have been even greater; but even so, much of the wealth which has gone into the lower income brackets has been generated through that industry. In the performance of its exports, in the quantity of capital equipment which it has made for the basic industries and other capital goods industries, and not least the larger selection of light engineering goods in the consumer market which it has made available, the engineering industry has played an outstanding part in bringing labour-saving devices, novelties and more goods at attractive prices to the British householder. The industry to-day makes more machinery for a greater diversity of uses, with more complicated methods of control and operation—all directly or indirectly channelled towards the preferences of the consumer—than ever before in its history.

The survey shows a good deal of diversity in spending habits as between one part of the country and another. There are such differences, already given some publicity, as the fact that the average northerner spends twice as much on fish and chips as the Londoner, taking income groups over all. On the other hand, the average weekly expenditure on food in the average Greater London household was 85*s.* 6*d.* compared with 78*s.* 6*d.* in the north of England. The figures have to be used with care since allowance in comparisons of this kind has got to be made for differences in average level of incomes between different areas.

If one looks at the pattern for durable household goods in which the light engineering industry is well represented, in the London area 19*s.* 1·6*d.* was spent on these goods, out of the total household income. In the south of England generally, excluding London, it was only 13*s.* 5·7*d.* per week compared with 19*s.* 11·9*d.* in Wales and 12*s.* 5·0*d.* per week in Scotland. Random figures such as these suggest both varying buying habits between different areas in the country and varying purchasing habits as between different income ranges. The survey, indeed, gives a good deal of evidence to support the already widely accepted fact that the proportion of expenditure devoted to essential items is basically affected by the size of the household's income and in the composition of the household unit as well. For example, the proportion of expenditure on food varied a good deal. It rose with a fall in income and with the increase in the number of children. To take two extremes, it varied from 20 per cent. in households with one child and an income of £20 per week or more, to 52 per cent. in households with four children living on a total income of less than £8 per week.

The inquiry is indeed a summing up of generally known trends of expenditure habit in the years since the war. In addition it gives a good deal of information on the expenditure pattern in different parts of the country and by different income groups. In due course a further inquiry will have to be made—say in another 10 to 20 years—into the spending habits of the public in order to revise once more the cost of living index. If economic progress for the average household is anything like as fast as it has been in the last decade there will be important changes to record. Leisure will probably be more important and gadgets and labour-saving devices will be even more rampant. One thing is certain: if there is to be progress and consequent changes in expenditure pattern, the engineering industry—more accurately, the engineering industries—will have a dominant role to play.

Cover Picture. *Checking at every production stage is particularly important in the case of the flow differential-pressure producer, where an undetected flaw would alter the characteristics of the tube. The liner itself is here being checked for accuracy of machining.*

* * *

Plain Words

There are people who think it only necessary to mention civil servants and cups of tea in the same breath to be acclaimed as humorists. Fortunately, they are nowadays comparatively few, but though their successors have discovered other lines of attack and other clichés, the target remains the same. We should never dream of venting our spleen on private servants; why should we be any less generous to public ones? The British civil servant is recognised throughout the world as a model of incorruptible efficiency, why should he be without honour in his own country?

To some, perhaps, the Civil Service is the symbol of nameless, faceless, unreasoning authority from which there is no appeal. Quick to recognise a potential dictatorship, we protect ourselves by a barrage of ridicule, sensing that once we let the bureaucrat feel he was a good fellow there would be no stopping him. Bureaucracy has a sinister ring, and even in the Soviet Union, which has no tradition of personal liberty, it is regarded as a legitimate object of abuse. There is scarcely an issue of *Krokodil* that fails to make some scathing comment on the hidebound public official.

But should we follow suit? In Russia the bureaucracy is used as a whipping boy to divert real criticism into a harmless and ineffective form. If we allow our newspapers, public speakers and professional comedians to channel our grievances into a habit of derision, we shall lose that very independence which we seek to foster.

Idleness, lack of humour or imagination, indifference to the public, and preoccupation with wordy and unintelligible forms and instructions are other criticisms levelled at civil servants. The official who accidentally dated an army officer's commission from 1043, and on receiving a request for appropriate back pay threatened to hold the officer responsible for the English defeat at Hastings, showed not only due regard for the public purse but also a proper levity. Imagination—indeed, vision—was displayed by one famous public servant when he insisted that a new plutonium factory commissioned by the Government should also be a power station. And to develop a lifelong hatred for civil servants as a result of being kept waiting in a food office by an overworked teenager is evidence of a maladjustment approaching the psychotic.

No doubt before the advent of Sir Ernest Gowers, memoranda were occasionally laboured in literary style; no doubt Ministry of Supply storemen have sometimes been instructed to stack items with the top at the bottom and the bottom at the top; no doubt regulations sometimes seem futile, and details required in application forms unnecessary; but there may be good reasons that only become apparent when the circumstances are fully known.

Administration is at worst a necessary evil, and we should be glad that our administrators are subject to at least remote control. As we drink our commercial cups of office tea, we might consider that though we pay heavily for civil services, we get our money's worth. Well, sometimes anyway.

MANAGEMENT, LIGHTING AND ENGINEERS

By W. Robinson,
B.Sc., A.M.I.E.E., F.I.E.S.

It is useful, from time to time, to re-examine our ideas on those fundamental provisions on which all else depends. Light, whether natural or artificial, comes second only to air, food and water in this category and it tends to be taken for granted in much the same way. A measure of the general indifference to the subject is given by the absence of practising lighting consultants, the small number of qualified lighting engineers and the infinitesimal proportion of the population with any knowledge of even the most elementary principles of lighting. One reason for this is that the human eye is a very tolerant organism which functions passably well under conditions ranging from moonlight to sunlight, a range of over 1,000,000 to 1 in light intensity. It has to be remembered also that artificial lighting is, in terms of human evolution, a very recent development indeed. It has taken less than a century for mankind to adapt itself to a day regulated by the clock instead of by the sun; it has taken less than half a century for electric lighting to oust all other light sources; and it has taken less than a quarter of a century for lighting technique to develop from a rather rough and ready side-branch of electrical engineering to the present-day combination of art and precise science. It is only natural that this extremely rapid development should have resulted in a wide gap between the potentialities and the actualities of electric lighting, but this gap is beginning to close and there is no time like the present for considering the implications of this to industry, management, engineers and, indeed, everybody, for there is no technological application so universally pervasive as lighting.

Fig. 1 Many examples still persist of "point by point" lighting in which no attempt is made to obtain uniform illumination or to provide a satisfactory environment after dark.

The most important change that has so far occurred in electric lighting is its cost. Twenty years ago the economic problem was to obtain sufficient light for the money available. Since then lamp efficiencies have been increased six-fold by the introduction of discharge and fluorescent lamps while electricity and lamp costs have been held steady, despite the continuous fall in the value of money. It is, in fact, possible to-day to get more than ten times as much electric light as could be bought for the equivalent expenditure 20 years ago. The problem of lighting economics to-day is, in consequence, quite different; it is, in fact, to equate the expenditure on lighting with the benefit obtained from it. This equation is complicated by the fact that there is no practical upper limit to the amount that can be used with advantage, always provided that the quality of the lighting, and the design technique, is commensurate with its quantity. The solution of this economic equation is a joint responsibility of management and engineers; the liberality of the former defines the scope of the latter, whose competence and flair determines the value received for the money. This management/engineer partnership is by no means unique but, in regard to lighting, it imposes a greater responsibility on management because there is no immediate penalty for a wrong decision neither is there any immediate reward for a liberal decision. An act of faith is, in fact, implied in the decision to install good lighting and it is vitally necessary for industrial management as a whole to recognise that good lighting, both natural and artificial, is a pre-requisite of a fully efficient factory and achieves the only result which justifies it, namely high productivity with high quality, by the combination of physical benefits such as better seeing leading to quicker and better work, better supervision, better housekeeping; physiological benefits, such as less fatigue, better health; and psychological benefits, such as a more cheerful labour force and a greater work impetus, which are probably the most important of all.

MANAGEMENT MUST SET THE PACE

Anyone who has had the opportunity of seeing a cross-section of British factories must have been struck by the enormous variation in lighting standards—this is amply illustrated by Figs. 1 to 4—and also by the widely differing outlook of both management and executives to artificial lighting. It will be noticed that, whereas there is a large measure of common accord on such matters as plant layout, power application, day-lighting, ventilation and heating, there seems to be no common ground regarding artificial lighting. In some factories the electric lighting is the responsibility of the plant department, in others it is left to the maintenance engineer, and very often it is left to the works electrician. Some managements appear to be interested only in lighting economies, and often a management with more liberal ideas receives little support from production executives, who would sooner see the money spent on plant.

There are, nevertheless, many well lighted factories to-day and it is almost invariably the case in such factories that management has provided the impetus, and that the high standard of lighting is apparent in efficiency and in labour

relations generally. It is not thereby implied that good lighting necessarily means high efficiency and smooth labour relations but rather that the standard of lighting is closely linked with the standard of management.

The problems which confront management concerning lighting are not solved, however, merely by the adoption of a liberal outlook. The correct temperature for a factory is narrowly defined; ventilation requirements can similarly be laid down fairly precisely; plant and its layout is determined by the nature of the factory's production, and all these requirements can be left to the appropriate engineers but lighting does not fall into any such tidy category There is no such thing as " correct " lighting, and, however competent an engineer may be in meeting a lighting specification, there is little likelihood that the specification itself will satisfy everybody. How can management decide what is reasonable provision for lighting, and how can they be sure that the lighting obtained is the best possible within that provision? Obviously it is not to be expected that management should become highly knowledgeable on the subject; but they can set the pace and that, after all, is the greatest function of management.

The most important features of a lighting installation are the amount of light, i.e., the illumination, and the quality of the lighting. For reasons already given the illumination to be provided cannot be precisely laid down but minimum values required for " adequate " visual performance of the various industrial tasks are the subject of authoritative recommendations published by the Illuminating Engineering Society (the I.E.S. Code for the Lighting of Interiors). Fig. 5 is the basic I.E.S. illumination chart upon which these recommendations are based. The engineer will, very properly, design according to these values unless he is authorised to exceed them but such authorisation is unlikely to be forthcoming unless it is realised that these values are based on a compromise between optimum visual performance and the cost of obtaining it. The I.E.S. Code is, in fact, based on the achievement of 95 per cent. of the best possible visual performance, whereas the parallel recommendations in the United States are based on 98 per cent. of visual performance, which requires illumination values at least twice the British recommendations. This difference is due to the different relation between lighting and other industrial costs which existed when the Codes were first published. It is questionable whether this difference in lighting standards can be justified to-day and advanced management in Britain is providing illumination considerably in excess of the recommended minima. This fact does not in any way detract from the value of the I.E.S. recommendations, which still provide a valuable safeguard against grossly insufficient illumination, and it indicates the role of management in working out the cost/benefit equation on which all else in lighting depends.

Another matter on which management needs to set the pace is the quality of lighting, for it is impossible for any engineer to produce even a reasonably lighted environment if he is constrained by the narrow managerial outlook, and slender budget, which are all too common, even to-day. The engineering aspects of lighting design and the features involved in lighting quality are to be discussed later but, from the point of view of management, it is vitally necessary to recognise that the old style lighting engineering is passing away because it belonged to the era of " point " light sources and the " dark, satanic mill." The old ways die hard, however, and it is not easy to convince either management or engineers that a lighting installation providing illumination comparable with daylight indoors involves a vastly different technique from one the function of which is mainly to bridge the gap between dusk and 5.30 p.m. Electric lighting is no longer a stop gap but is rapidly assuming full partnership with daylight, and even replacing it completely, as in the windowless factory.

LOOKING AT LIGHTING

There is a considerable tolerance of bad electric lighting which, to be frank, extends from management downwards. This largely arises from the fact that, although no one can avoid seeing it, very few people look at it, or consciously analyse its merits. It is also remarkable how little use is made of lightmeters in industry, and yet these invaluable instruments cost as little as five guineas, can be carried in the pocket and can be used with the same ease as a thermometer. The requirements of good lighting will be dealt with later but management can play a most valuable part, without delving into technicalities, by being critical and by encouraging a critical outlook among executives. Even a brief visit to any part of a factory is sufficient to establish whether there is glare from insufficiently shielded or unshielded lamps; the sight of any improvised shielding is a sure sign that attention is needed to this. A glance at the ceiling and upper walls is enough to show whether they are getting enough light. If the ceiling looks dark or if there is a strong shadow line on the walls, then action is called for. Floor shadows similarly invite attention for they indicate substandard lighting. Dirty lamps and reflectors should particularly concern managment for they represent not only waste but also indifference. Bad lighting is a reflection on management, dirty lighting equipment is an indictment of managers and executives alike.

WHERE LIGHTING GOES WRONG

The major function of management is to exercise judgment, to make decisions and to see that they are carried out. The lighting of a

Fig. 2 The use of a symmetrical lay-out of lighting fittings greatly improves working conditions, but often the illumination is inadequate.

Fig. 3 The illumination in this workshop is adequate but there is still little regard paid to its appearance after dark. Note the unlighted ceiling, producing an excessive and undesirable contrast between upper and lower parts of interior.

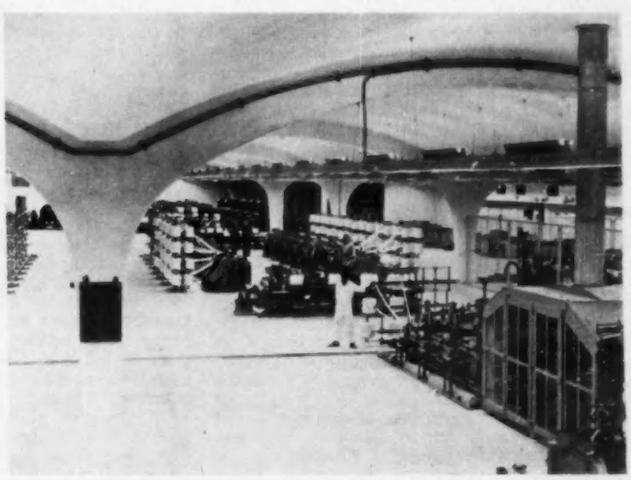

Fig. 4 An example of lighting designed to provide bright surroundings as well as adequate process lighting. Illuminating the ceiling by up-turned reflectors produces a daylight effect and reduces the apparent brightness of visible lamps. (By courtesy of the International Lighting Review.)

factory is first and foremost an indication of the quality of managerial judgment. If, as is so often the case, it is judged unimportant then there is little hope for its improvement since executives are not prone to take up unpopular causes. Even indifference, however, is better than the enthusiasm displayed by some managements for "do it yourself" methods. The author has been invited more than once to comment on lighting schemes only to find that the main point of the exercise was to obtain support for whittling down the proposals. In one case the author was called in to make suggestions for improving unsatisfactory fluorescent lighting in a large general office only to find that the lighting concerned had been the subject of recommendations made by him some years previously. These had been ignored and instead the management had bought a large number of totally unsuitable, but obviously cheap, lighting fittings and had instructed the electrician to hang them up. In another factory the management instructed the maintenance electrician to prepare a fluorescent lighting layout and on its completion proceeded to eliminate every fourth fitting on the grounds that they were unnecessary.

Managements should steer a course between the Scylla of indifference and the Charybdis of interference. They should know what bad lighting is when they see it, and should be guided by competent lighting engineers as to what is good lighting, for there is more to the latter than meets the eye. Above all they should bear in mind that no factory which is badly lighted can be really efficient. Bad lighting is bad management.

LIGHTING INFORMATION AND EDUCATION

It is appropriate at this point to review the present channels of lighting information and education. Lighting engineering is not yet fully established as a profession and the almost complete absence of independent lighting consultants is a severe handicap to the spread of new techniques. Nevertheless the links between research and application have been greatly strengthened and lighting engineering as a full-time profession is gaining more recruits. It is significant that lighting is becoming a specialist subject in certain university engineering courses and there is less tendency to dismiss it as an adjunct to the physics curriculum in conjunction with sound and heat. Even more significantly, the Institution of Electrical Engineers now includes illuminating engineering among the optional specialist subjects in their membership examinations, thus giving a considerable stimulus to the study of the subject in universities and technical colleges. There is a growing awareness of the need for more attention to be given to lighting in the education and training of architectural students, and lighting courses are part of the curriculum of an increasing number of architectural schools.

The improved status of lighting engineering owes much to the work of the Illuminating Engineering Society which, although fundamentally a cultural society whose membership is open to all, nevertheless includes among its membership most professional lighting engineers and contains a class of diploma membership requiring rigorous examination and professional attainments for acceptance therein. The Society, recognising the need to narrow the gap between research and application, has recently re-formed its Technical Committee (which in its early form was responsible for specifying illumination requirements in the I.E.S. Code) and one of its main functions will be the translation of advanced lighting concepts into engineering terms and the "processing" of new lighting design data for practical use. The chief function of the Illuminating Engineering Society, however, continues to be that of bringing together all those who are interested in lighting in any of its various forms and in providing liaison with, and guidance to, other bodies, including the Government, on lighting matters.

A sister body to the I.E.S. is the Association of Public Lighting Engineers whose membership consists largely of lighting engineers and members of local authorities. The A.P.L.E. holds an annual national conference at which the views of local authorities, as the main public lighting users, can be exchanged with those of lighting engineers and equipment manufacturers.

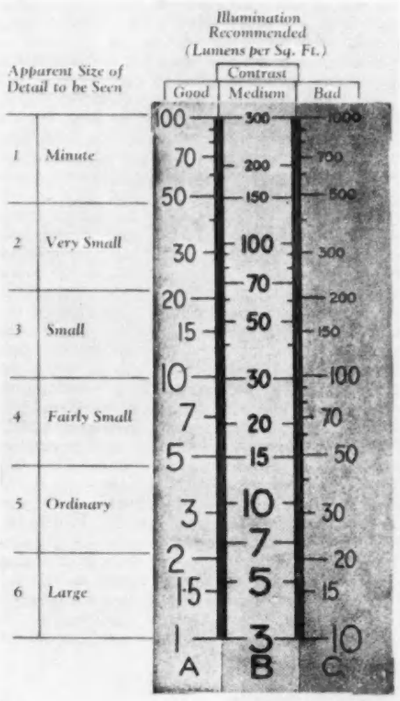

Fig. 5 Basic illumination chart, produced by the Illuminating Engineering Society. The chart enables the minimum illumination to be determined for any task by reference to the size of detail and degree of contrast required.

Another important channel of lighting information is the Lighting Service Bureau. The Bureau exists to promote better lighting by a national demonstration and lecture service, is available for free advice to all and publishes a wide variety of handbooks and literature for use by the public as well as engineers.

Mention should also be made to the work of the British Standards Institution whose standards on lamps and lighting equipment are the basis of all reputable manufacture. Probably less well known to non-specialists are the B.S. Codes of Practice which are proving valuable to architects, local authorities and others requiring practical guidance. The recently issued Codes of Practice on Street Lighting, Parts 1 and 2, form the basis for all street lighting modernisation now being undertaken.

There is much activity in the international sphere, the main official channel being the Commission Internationale d'Eclairage (C.I.E.), formerly known as the International Commission on Illumination. British co-operation is through the National Illumination Committee. The C.I.E. has a British President for the current four-year period. The work of this organisation is probably not widely known but it has achieved international uniformity in the colours of traffic lights, and established a system of trichromatic colour specification which has considerably advanced colour standardisation and technique. Important work is now in progress which may lead to a much greater measure of international agreement on systems of automobile head lamp and pass lights, a matter of considerable importance both for tourists and exporters. Of equal value is the regular interchange of views and experience concerning lighting practice in the many member countries, and the personal contacts resulting from the four-yearly Congress and membership of the C.I.E. working parties.

This is the first of a series of three articles by Mr. Robinson. The second will be concerned with current design practice and the third will discuss longer-term issues for the lighting engineer.

Automobile Engineering

RILEY RETURNS TO SMALL CAR MARKET

New 1½ Litre Saloon Does Nearly 90 m.p.h., 3·73 to 1 Top Gear

The new Riley One-Point-Five, which brings Riley back into the market for small high performance cars where their fame was originally established, seems to be one of the better results of the continuous shuffling of body pressings, power units, and gearboxes which goes on at the B.M.C. It is a development of the formula already employed in the Wolseley 1500, using the same basic structure, and body panels and engine, but it has more power, better finish, and larger brakes. The front end is more graceful and the colour divisions on two-tone cars are arranged in a way which emphasises length rather than height. The 1,489 c.c. four-cylinder engine is quite close to the one used in M.G. cars, with two SU carburetters and with 8·3:1 compression, giving a gross 68 b.h.p. at 5,400 r.p.m. (62 installed) with maximum torque of 83 lb.-ft. at 3,200. Fourth speed is equivalent to most overdrives (and gives the car 18·5 m.p.h. at 1,000 r.p.m.).

The car is quite compact, with a frontal area of only 18·54 sq. ft., and a maximum speed of about 88 m.p.h. is said to be obtainable. As it is essentially a four-seater, a well-placed central gear lever is used. Unfortunately this body shell, which seems to be the basis of an extensive B.M.C. production programme, lacks headroom in the rear seats, although a little more might be won by detail modifications to seat design.

The brakes are Girling with drums 9 in. by 2¼ in. at front and 8 in. by 1½ in. at rear, giving a total friction lining area of 124 sq. in. for a kerb weight of 2,060 lb.

Companies in the News

Reorganisation at I.C.I.

Imperial Chemical Industries Limited have the Free Trade Area much in mind at present. Several plans announced last week on the reorganisation of the group's activities should stand it in good stead for a more competitive European market. I.C.I. and Yorkshire Copper Works Limited have decided to combine their activities on an equal participating basis in the manufacture of copper and copper alloy tube and plate. It is pointed out that they have between them extensive research, development, technical service and sales facilities, and that the merging of these into a single enterprise will promote " economy, efficiency and service to the customer."

Meanwhile, internal organisational changes at I.C.I. are also on foot. With the rapid expansion in the output of petrochemicals and thermoplastics in recent years, it has become necessary to modify management structure to technical change. Hitherto the Billingham Division of the group has been concerned with the manufacture of a wide range of chemical products, among which organic chemicals based on petroleum have assumed increasing importance in recent years. A new Heavy Organic Chemicals Division is to be set up to take over, as from January 1, 1958, the Billingham Division's interests in these products. At the same time, all responsibility for polythene development and production will be vested in I.C.I.'s Plastics Division. Hitherto a major part of production, research and development work on polythene has been in the hands of the Alkali Division, where it was first developed. Polythene output has, however, been expanding so fast in recent years that it is now apparently thought necessary to bring all plastics production under unified control.

Part of I.C.I.'s new Heavy Organic Chemicals Division may eventually find itself located in the West Country. Plans for a plant at Avonmouth costing £100 million were announced by I.C.I. in June, 1957. The new works are to manufacture a wide range of chemicals based largely on petroleum, and the outline plan has now been approved by the Gloucester County Council.

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Cautious Optimism on the Wear

Dr. E. P. Andreae and Sir Henry Wilson Smith—chairman of William Doxford and Sons and of the Sunderland Shipbuilding Dry Docks and Engineering Company, respectively—indicate in their statements at the annual general meetings of their companies that there is no shortage of work in the Wear dockyards at the moment and that there is unlikely to be any for some years. They do not fall under the same gloomy spell which is affecting the statements of shipowners at the present time. Dr. Andreae, who is retiring this year from the chairmanship (but remaining on the board at his colleagues' request) considered that " on the whole " his company could " look forward to full employment for several years ahead and regard the future with sober confidence." Sir Henry Wilson Smith also thought that his group of companies appeared to be " assured of a high level of activity for some years to come." Each of them, however, sounded a note of caution.

There are signs of greater difficulty in the making of profits, Sir Henry said, and that " in these circumstances " his companies must put themselves in a position " to cater for business in the manner required by modern conditions." This means large-scale development and capital expenditure which, on two major products alone, will cost over £1 million and may necessitate the raising of additional capital. With the Capital Issues Committee's mood as it is at present, there is not much chance of permission being forthcoming. Profits are therefore vital if the group, and this applies to the whole industry, are to adapt themselves to the building and repairing of the larger ships.

Dr. Andreae's point related to the shipping industry. " Were it feasible to relate the prospects of a shipbuilding company solely to the size of their order book," he said, " it would be easy for us to forecast with certainty a period of maximum employment covering at least five years ahead." But it would be unwise to ignore the conditions affecting the shipping industry, including both the credit squeeze and the low level of earnings. In these circumstances it would be " unrealistic not to visualise the possibility of some re-adjustments of an order book." The underlying policy, however, is that shipbuilding is as strong as the economy as a whole, and perhaps a little stronger.

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Qualcast and Kaufmann

The proposed merger between Qualcast Limited and H. Kaufmann Limited, announced last week, will cause little surprise to those who have followed the fortunes of the light engineering industry over the last year or so. The interests of the two companies are broadly similar, each being concerned with the manufacture of lawn mowers and a variety of light engineering products. They also share the same problems. Both Qualcast and Kaufmann have been going through difficult times lately, both as a result of inflationary cost pressures and of severe competition in export markets.

Mr. J. E. V. Jobson, the chairman and managing director of Qualcast, in his review at the company's annual general meeting at Derby last week, gave four main reasons to explain the large fall in profits experienced by the company in the year ended June 30, 1957. These were the sharp increase in prices of foundry raw materials, particularly pig iron, the rising pressure of wage costs as a result of the engineering wages awards, the recession in the motor industry and the engineering strike. In the year under review profits before taxation fell by 31 per cent. to £547,283. " During the past year," said Mr. Jobson, " we have been upset more than I ever remember by circumstances outside our control." Mr. J. F. Perry, chairman of Kaufmann, told much the same story to his company's shareholders in July, 1957. Kaufmann have also been affected by the Government's policy in reducing armament orders, and by import restrictions and strong competition in overseas markets. In the year ended December 31, 1956, profits before taxation amounted to £402,556, a 17 per cent. fall from the 1955 total.

In the circumstances, it was logical that the two companies should wish to avoid any further difficulties which might arise out of stronger competition with one another. Integration should help the two companies to avoid wasteful duplication, and by rationalising output to achieve reductions in costs. This would be of particular value in the export market. The chairman of Qualcast referred particularly to the value of the merger in helping to sell in the dollar area, but both companies must have given considerable thought to the competition they will meet in the European Free Trade Area.

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Mergers not Needed

The increase in the profits of the Westland Group (Westland Aircraft, Westland Engineers and Normalair) led their chairman, Mr. Eric Mensforth, to tell shareholders at their annual general meeting that " the results achieved by your relatively small company by specialised efforts are a striking refutation of the advocates of great mergers or of a state-controlled aircraft industry." Profits rose from £0·96 to £1·12 million which, for a company who have pioneered the design and manufacture of helicopters in Europe, is a fine achievement.

Concerning the future, Mr. Mensforth had no feeling of depression. He interpreted the Government's Defence White Paper issued last April as a reasonable indication that the new policy " must lead to an increased use of helicopters by the Armed Forces." Meanwhile, " specialist civilian uses continue to develop in which the helicopter increasingly shows its versatility and flexibility in operating without restrictions of terrain, route or terminal." He gave details of the company's range, which now includes four machines, the Widgeon, Whirlwind, Wessex and Westminster, able to lift ½, 1, 2½ and 5 tons respectively. While Mr. Mensforth fully expects a growth in competition —Germany has not yet made her presence felt in this field and will certainly claim a place in the export markets—he considers that the experience and lead his company have acquired, the links " so firmly and usefully established " with Sikorsky Aircraft and the experience they have of private ventures, add up to " a position of sufficient strength to enable us to look to the future with reasonable confidence."

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Appliances by the Million

The amazing progress made by Morphy-Richards since the war continues. Turnover for the year ended June 30 has passed the £5 million mark for the first time and the sales of their largest subsidiary, Astral Equipment, rose by 2 per cent. to £900,000. These increases have been secured without any increase in prices. In the case of one of their main lines, the " Senior " iron, the price has been the same since 1952. Despite this price policy, profits have risen by 4 per cent. This is not as much as the rise in turnover, for it reflects the extra cost of providing and equipping two new factories as well as the general rise in the costs of materials and labour; there has in fact been a substantial increase in productivity for almost every year in the past ten.

Nothing appears to check the progress of this enterprising firm. The parent company this year opened a new factory in St. Mary Cray which doubles their capacity, and Astral took possession of a new factory at Dundee which doubles their own capacity. The group's turnover during the first quarter of this year shows a continued increase, and it is clear that results for the whole will show both a much larger output and the advantages to be derived from new factory equipment. Demand for all main products, at home and abroad (exports last year were £1 million or 20 per cent. of the total), indicates that there is room for further expansion for well designed appliances produced in real volume. It is this factor, and the deliberate policy of keeping prices as low as possible to secure the maximum turnover, which has made Morphy-Richards the power they have become in the world's domestic appliance market. And still they are managed by the founders, Mr. Morphy and Mr. Richards.

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American Rubber Research

An ambitious research programme involving the expenditure of £45 million over five years is announced by the United States Rubber Company. The programme is of direct interest to industry in this country since the North British Rubber Company, Limited, in Scotland is expected to benefit directly.

The American company points out that the scheme has three main objectives. The first of these is the development of trouble-free passenger car tyres at popular prices. No details are given of the line of development proposed but there are at present three experimental tyres undergoing tests, each made with an experimental type of synthetic rubber. The second objective is to bridge the gap between rubber and metals. A new list of rubber types and new types of plastics as well as blends of the two are under develop-

ment which it is hoped will provide a range of materials of hardness, toughness and elasticity which will give a graded selection of products from rubber to metals. The third objective is connected with atomic energy. Ways have been found of curing rubber by radiation and a new series of processes is envisaged which will enable atomic energy to perform the work of heat, pressure, catalysts and chemicals. Work is also to go forward on special types of rubber to withstand atomic radiation at atomic energy plants.

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Motor Business

The position of the manufacturers of components for the motor vehicle industry has been exceedingly difficult during the past year. At the beginning there were severe cuts in orders, when most of the component firms were still busy attempting to increase their capacity to a level sufficient to meet the motor industry's vast plans for expansion. Then, in the summer months, came a revival in car demand requiring peak output. Now there is the threat of more controls on the sales of private cars on the home market and the prospects of even more violent fluctuations in the coming year.

The chairman of Adamant and Western Engineering Limited, Mr. F. G. Matravers, told the company's shareholders how these fluctuations have affected the group's operating companies. " From a slight improvement in the rate of deliveries over the last two months (May and June) there were indications that the requirements of Adamant's customers were increasing, no doubt reflecting the increased vehicle exports which have recently been announced, and there were grounds for expecting that Adamant would again be in full production of new gears on order in a comparatively short space of time. There followed, however, the increase in the Bank rate and it is too early to predict how this will effect the demand for Adamant's products. Western were also adversely affected and their steering-gear section, which had been equipped with the most modern automatic plant for the production of the smaller types of steering gears for use on private cars, " has not come up to the expectations which we had for it." In such circumstances it is inevitable that the suppliers of components to the car industry will seek to lessen their dependence upon it by diversifying their output. The development of Western's interests into the field of printing machinery, electronics (automatic weighing systems and other devices) and atomic energy indicates that the group are fully aware of the need to lessen their dependence on the motor-vehicle and, in the case of Western, on the aircraft industries.

Letters to the Editor

FALL OF A SPUTNIK

SIR, Various and progressively changing predictions have appeared in the Press concerning the date of demise of the *Sputnik I* and its attendant rocket. As the orbits and periods are known it should be possible to improve on guesswork.

Measurements made in the first few days gave the *Sputnik's* greatest and least heights as about 600 and 120 miles respectively and its period as 96 minutes, decreasing daily by 1·5 seconds. This decrease shows that its average height is coming down at the rate of 0·75 mile per day. Owing to the great variation of height nearly all the retardation must take place in a short stretch of orbit near the lowest point. If, however, a satellite receives a sudden check at one point on its orbit it still comes back to the same point the next time round, the effect of the check being to reduce the major axis of the orbit so that its height is lower on the far side of the earth. The low point of the *Sputnik's* orbit must accordingly be descending very slowly whilst the high point is coming down at nearly 1·5 miles per day. At this rate the height would become equal and the orbit circular after 320 days. As the highest point falls the length of orbit over which resistance is appreciable increases; making allowance for this and for the increase of resistance due to the small fall of the low point the time is reduced to a half, 160 days.

When the orbit is nearly circular the *Sputnik* will encounter resistance all the way round and will rapidly fall. These figures put its date of death some time in March.

The rocket, starting behind the *Sputnik*, overtook it and lapped it in 23 days. From this its total acceleration is found to be 3·0 seconds per period per day, twice that of the *Sputnik*. It is accordingly descending twice as fast and should fall about Christmas, having lapped the satellite about 20 times.

It is not necessary to know the air density in order to make these predictions; in fact the air density can be calculated from the observations.

Yours faithfully,
C. H. BOSANQUET.

Dingestow,
Fairfield,
Stockton-on-Tees.
November 1, 1957.

(Editor's note: Soviet views on satellite lifetimes are mentioned in column three.)

ILLUSION

SIR, Mr. E. P. Ward's enlightening series on Soviet engineers and engineering was most enjoyable. And they were concluded by an excellent summary on page 482 of ENGINEERING on October 18. However, I must point out an error in the caption below the aircraft which was illustrated in that article. It is referred to as a Tu 110, but actually it is an Ilushin (one might say illusion) Il 18 Moskva. You may be interested to know that the Tu 110 is a four-engined turbojet aircraft and that it is a larger version of the Tu 104, which is a two-engined turbojet.

Yours faithfully,
R. A. SHELLEY.

59 Northumberland-crescent,
Bedfont, Middlesex.
November 2, 1957.

(Editor's note: Mr. Ward apologises for the error; the aircraft illustrated on page 483 of our issue of October 18, 1957, was in fact an Ilushin 18—" Moskva," correctly described in the caption as a turboprop. We regret the perpetuation of a confusion which occurred in the original source.)

CAULDON CEMENT WORKS

SIR, In your issue of October 25, on page 535, you published a description of the new Cauldon Cement Works, built for the Blue Circle Group of Companies, which we read with great interest. Correctly, you state that the grinding mills for the raw meal and coal for this particular plant were designed and made in Germany. May we, however, as suppliers of this plant and as the licensees of the British patents, point out that the mills were made in Germany, rather than here, only because of the previous experience of fabricating such plant that existed there combined with the great urgency and speed with which Cauldon was built. For the future there is now no reason why similar plant should not be made here.

Yours faithfully,
W. KULKA,
P.H.I. ENGINEERING LIMITED.

250 Coastal Chambers,
172 Buckingham Palace-road,
London, S.W.1.
October 30, 1957.

SATELLITE TIMETABLE

It is likely that calculations based on observations of *Sputnik I* are giving an accurate picture of the density variation at heights above 100 miles. This in turn will permit more accurate prediction of the behaviour of future satellites. A Soviet paper read at the Barcelona Conference* detailed a method of calculating the lifetime of any earth satellite in terms of its total number of revolutions, N.

The authors say that

$$N = \frac{\nu}{c}$$

where c is a constant depending on the design of the satellite and ν is a universal function of the height of the apogee (h_a) and that of the perigee (h_π) of the orbit. Once ν has been computed it is relevant to all orbits. The function also predicts the orbit parameter changes in time for any given satellite parameters and for a sufficient wide range of initial orbit parameters. The paper contains a table setting out the value of ν for various perigee and apogee heights.

However, the evaluation of ν is dependent on knowledge of the density of the upper atmosphere and the authors remark " Because of the lack of reliable data on upper atmosphere parameters, the calculations can only be regarded as tentative." From their calculations they are able to draw several conclusions as to the way the orbit parameters vary during the lifetime of the satellite. The apogee and perigee heights decay monotonically, and for all elliptic orbits the velocity of decay of the apogee is greater than that of the perigee. As an example, they point out that " an orbit with a perigee height of 300 km. and an apogee height of 700 km. will experience a drop in perigee of about 6 km. for a 100 km. decrease in apogee." The eccentricity of the ellipse tends to zero and, as it does so, the difference between the rate of decay of the apogee and perigee gets less.

This emphasises the point brought out by Mr. Bosanquet in his letter on this page: the most important factor affecting the life of the satellite is the atmospheric density in the region of the initial perigee. The life of the satellite will be approximately inversely proportional to the air density in the initial perigee region.

The authors calculate the lifetime of a spherical satellite, diameter 0·5 m. and mass (G) 10 kgm. They assume a 1½ hour orbit and take the aerodynamic resistance coefficient (C_x) as 2·0; denoting the area relating to it by F. The constant c is calculated as

$$c = \frac{C_x F}{G} g \quad \text{where} \quad F = \frac{\pi (0{\cdot}5)^2}{4} = 0{\cdot}385.$$

For perigee and apogee heights $h_\pi = 360$ km. and $h_a = 800$ km., their table gives $\nu = 2{,}760$. Simple calculation yields,

$$N = \frac{\nu}{c} = 7{,}200 \text{ revolutions.}$$

Assuming a 1½ hour orbit, the life of the satellite is 1 year and 3 months.

A similar calculation can be made for *Sputnik I*. In this instance, the diameter of the sphere is 0·58 m. and its weight is 83·6 kgm. The resistance coefficient can again be taken as 2·0. Observed values for h_a and h_π are 832 km. and 192 km. The value for c now becomes 0·062, and from the table, $\nu = 60$. These figures give *Sputnik I* a lifetime of about 60 days.

It is worth remembering that the Soviet paper was prepared before the launching of *Sputnik I*. If Mr. Bosanquet's prediction is correct it appears that the density of the upper atmosphere above 100 miles is less than half of what it was previously supposed to be.

* D. E. Okhotsimsky, T. M. Eneev and G. P. Taratinova, " Determination of the Lifetime of an Artificial Earth Satellite and a Study of its Secular Orbital Disturbances." The authors are members of the interdepartmental commission on interplanetary communication, of the astronautical council, U.S.S.R. Academy of Sciences.

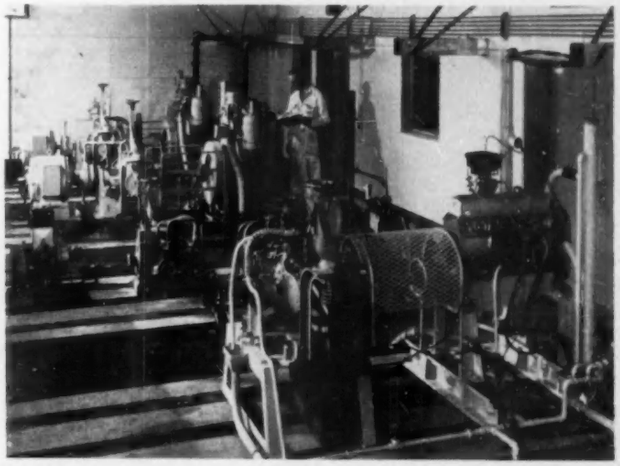
Metals and Materials

MOBIL OIL COMPANY'S LABORATORIES AT CORYTON

Specially designed and constructed to house all the facilities needed to control the quality of the firm's products, to conduct development work, and to undertake technical services for the benefit of marketing and distributing firms and manufacturers, the new technical services laboratories of the Mobil Oil Company Limited, at Coryton, Stanford-le-Hope, Essex, have now been completed and the staff and their equipment moved from their previous situation at Wandsworth, London, S.W.18.

The building, which we were given an opportunity of inspecting recently, has a total floor area of about 25,000 sq. ft. and has been erected on Franki piles. It is a reinforced-concrete framed two-floored structure and is roughly U-shaped in plan. Partitions to the laboratories and other rooms consist generally of cellular blocks and, in some cases, the partitions are prefabricated and capable of being removed speedily to allow alterations to be made in the layout if and when required. The building contractors were John Laing and Sons, Limited, the architect, Mr. S. Greenwood, and the quantity surveyors, D. G. Burrell and Partners.

While no fundamental research is carried out at Coryton, the work of the laboratories includes the adaptation and re-formulation of new and existing products introduced into this country.



View of four of the seven engine test beds in which petrol and Diesel engines are operated to evaluate the performance of lubricants and fuels. The beds consist of mass-concrete blocks, each weighing 20 tons, and are supported on spring suspension units to reduce sound transmission.

In addition, samples of all industrial and internal-combusion engine lubricants, fuels and greases are sent from storage and distribution centres and service stations throughout the country to ensure the maintenance of quality up to the point of consumption. Moreover, some 200 samples are received every week for examination and analysis from ships, industrial plants, and internal-combustion engine installations in all parts of the country and sometimes from abroad, in connection with field problems.

Another important aspect of the quality-control programme is the continuous assessment of marketing requirements by means of tests carried out in actual engines and rigs to evaluate the performance of fuels and lubricants. Seven engine test beds are provided for this purpose. The beds consist of mass-concrete blocks, each weighing 20 tons and supported on spring suspension units to reduce sound transmission. The partitions in the test-bed laboratory are permanent and are constructed of brickwork. The walls and ceilings are faced with special metal acoustic tiles.

ANTI-CORROSION PRODUCTS AND SERVICES

One of the principal functions of a National Anti-Corrosion Week, a campaign lasting from October 14 to 19 and sponsored by the Leonard Hill Technical Group, Stratford House, 9 Eden-street, London, N.W.1, publishers of the monthly periodical, *Corrosion Technology*, was a Corrosion Exhibition, held in the Old Hall of the Royal Horticultural Society, Westminster, London, S.W.1, from October 15 to 17. Some 60 manufacturers and suppliers of anti-corrosion products and services displayed many recent advances in this field.

A newly-developed range of copper-manganese-aluminium alloys of high strength, toughness and hardness, which, it is stated has shown its ability to withstand corrosion, corrosion fatigue, cavitation erosion, impingement attack, abrasion and wear, was shown on the stand of J. Stone and Company (Charlton) Limited, Woolwich-road, Charlton, London, S.E.7. The percentage composition of these Superston alloys, as they are called, lies within the following range: manganese 11 to 13, aluminium 7 to 9, iron 2 to 4 and nickel 1·5 to 5; copper constitutes the balance. The alloys are available in the form of castings, plate, sheet and strip, bars and wire, and forgings and they are stated to possess excellent welding characteristics. The fatigue strength of as-cast Superston 40, an alloy in the group, after 100×10^6 reversals, is given as $\pm$ 15·0 tons per sq. in. in air and $\pm$ 9 tons in salt spray. The fatigue strength of as-forged material, under corresponding conditions, is $\pm$ 20 tons per sq. in. in air and $\pm$ 9·8 tons in salt spray. The material has found application in the oil, chemical, marine and electrical industries.

The remarkable corrosion-resistant properties of titanium were stressed in the chemical and oil industries section of the display of Imperial Chemical Industries Limited, Metals Division, Birmingham. An interesting development was furnished by examples of titanium bi-metal plate and tubes which are manufactured for the purpose of resisting different corrosive media inside and outside the plate or tube.

Zinc-alloy "C-sentry" anodes for the cathodic protection of ships, piers and equipment carrying sea water used in the petroleum industry was one of the main items on the stand of Imperial Smelting Corporation Limited, 37 Dover-street, London, W.1. The method of installing the anodes so as to give the best protection to the hull of a vessel was demonstrated by means of a model of a liner.

Protectives applied to steel surfaces by painting were shown by several firms. Thus Secomastic Limited, Western-road, Bracknell, Berkshire, depicted the scope of their zinc-rich paints in combating corrosion. The preparation employed in their "cold galvanising" method is Galvafroid, a fluid composition containing metallic zinc powder, a plastics binder and a solvent. The content of zinc in the dry film is stated to amount to from 92 to 95 per cent. and the paint is applied over the metal by brush or by spraying. A new development constituting an expoxy-resin base heat-resisting grade of paint (CWS4) was exhibited for the first time.

Drynamels Limited, Shaftmoor-lane, Hall Green, Birmingham, 28, were also showing a zinc-rich paint for use as anti-corrosive priming material for the protection of iron and steel surfaces. This paint, Drygalv, may be applied by brush or spray gun and it is claimed that the dried film contains 95 per cent. of metallic zinc, the metal particles being in electrical contact both with themselves and with the underlying iron or steel surface.

A treatment of rusted metal surfaces prior to painting was demonstrated by the Plus-Gas Company, Limited, 1-11 Hay-hill, London, W.1, in addition to their now well-established formula "A" fluid rust remover for the dismantling of corroded and rust-bound machinery, and formula "B" fluid for the protection of new plant and components. The firm's new formula "E" for the preparation of rusted surfaces prior to painting is a tannating process. It is claimed that the tannins present in the fluid react with the oxides on the steel surface to form a tannate/gamma-ferric-oxide complex thus creating an insoluble corrosion-resisting film which affords an excellent bond for painting and other protective coatings. As is the case with the older products of the company, the new fluid, which is applied by brushing or spraying, is non-acid and non-toxic and, therefore, non-injurious.

Several manufacturers were showing examples of anti-corrosive plastics equipment. Thus, BX Plastics Limited, Higham Station-avenue, London, E.4, displayed chemical plant made from Cobex rigid vinyl sheet, a thermoplastic material highly resistant to chemical corrosion, both acid and alkaline. The material is easily fabricated and hot-gas welded and, in addition, it is light and tough and dimensionally stable. Cobex is now extensively employed for the construction of exhaust ducting, tank linings, fans, fume scrubbing equipment, pickling baskets, trays and racks, buckets and other non-corrodible equipment.

Non-metallic rigid polyvinyl chloride electrical conduit fittings and accessories were to be seen on the stand of Ega Electric Limited, Holyhead-road, Wednesbury, Staffordshire. The material is used for electrical installations in corrosive atmospheres such as occur in tanneries, chemical works, salt plants and electroplating shops.

The Kestner Evaporator and Engineering Company, Limited, 5 Grosvenor-gardens, London, S.W.1, were showing examples of their well-known Keebush corrosion-resistant plastics material in the form of pipes, valves and other equipment. Keeglas, the latest addition to the firm's products, is composed of glass fibre and epoxy and other resins.

The use of pressure-sensitive tapes as a protection against corrosion is apparently increasing in importance. Smith and Nephew Limited, Bessemer-road, Welwyn Garden City, Hertfordshire, were showing their Lassovic PWG tape which has a plasticised polyvinyl chloride base material spread on one side with a pressure-sensitive key-coated adhesive. The tape is stated to have a high tensile strength, to mould easily and to be highly resistant to water, oil, acids, alkali and bacteria. The tape can be applied to metal structures and pipelines conveying oil, water or gas or carrying high electrical voltages, and placed above or below ground.

The Minnesota Mining and Manufacturing Company, Limited, 167 Strand, London, W.C.2, were also showing a polyvinyl chloride tape with

Continuing **Metals and Materials**

pressure-sensitive adhesive. The tape, named Scotchrap, conforms smoothly to odd shapes and contours in pipelines and is also available in extra wide rolls for the protection, from corrosion, of welded joints on large-diameter pipes and tubes.

Pipe wrapping material of a different type was to be seen on the stand of Regina Glass Fibre Limited, Rayner Mills, Liversedge, Yorkshire. This was Versil glass felt which is intended as a reinforcement or carrier for the bituminous or tar coating applied to buried steel, gas and water service pipes and mains to prevent corrosion. It is pointed out that the flexibility of the material allows the smallest pipe to be wrapped satisfactorily and furnishes close and tight wrappings on pipes of all sizes.

The General Rubber Goods Division of the Dunlop Rubber Company, Limited, 19 New Bond-street, London, W.1, were showing examples of the use of synthetic materials as well as rubber for the lining of chemical plant for heavy duties. The materials exhibited included Butyl, Hycar ebonite and Hypalon. The Semtex Limited Industrial Division, another Dunlop Company, were showing various types of bricks and tiles laid in anti-corrosive cements and of glass ashlars laid in latex cement, an application employed on the walls of a brewery and as an anti-abrasive lining to fuel bunkers.

FROM COAL TO COKE

The production of coke from indigenous coals, particularly the large, strong metallurgical fuel suitable for the blast furnace, has given rise to many problems in France in recent years. In Lorraine, the source of much of the country's iron ore and where there are also considerable reserves of coal, the collieries have made coke for a long period but this fuel is too small and friable for use in blast furnaces charged with the relatively low-grade ore native to the area, and the coke is suitable only for the domestic market. To meet the needs of the ironworks it has been the practice for coke to be imported from the Ruhr or for coking coals to be purchased in order that they might be blended with Lorraine coals to give the properties required of a metallurgical coke.

In an endeavour to solve the problem of producing a satisfactory metallurgical coke from the highly swelling coals of Lorraine, a programme of research was initiated in 1950 by the Centre d'Etudes et Recherches des Charbonnages de France, usually abbreviated to CERCHAR, the research organisation of the nationalised coal industry in France. The general progress made with these investigations was referred to in the course of the sixth Coal Science Lecture of the British Coal Utilisation Research Association, Leatherhead, Surrey, delivered in London on October 16, by this year's recipient of the Coal Science Medal, Mr. Raymond Cheradame, technical director general of CERCHAR. Mr. Cheradame who had entitled his lecture "From Coal to Coke," stated that, prior to 1950, the research work of his organisation had been concerned largely with a scientific study of the fissuring of coke during its formation, and little attention had been given to the direct improvement of large-scale coking processes.

Since 1950, however, basic researches carried out in the Centre's Verneuil Laboratories, near Creil in the Oise Department, both in laboratory apparatus and in small ovens treating charges of up to 20 kg. of coal, had been supplemented by practical tests on full-scale experimental ovens erected at Marienau in the Lorraine coal basin. From the experimental results so far obtained on the carbonising of blends of coking coals with "flaming" coals having a high volatile matter content, two conclusions had been arrived at. In the first place, it had been found that the anti-fissuring efficiency of a fusible coal was the greater, the higher the temperature of re-solidification. Secondly, the richer in volatile matter and the less fusible a "flaming" coal was found to be, the greater was the fusibility and the proportion of volatile matter needed in the coal to be blended with it.

Coke breeze and chars had been used as inert additives in blends, but such materials should be substances which did not contract much in the region of re-solidification. At higher temperatures, however, stresses were bound to be set up owing to differences in the contraction rates of the coal and the inert constituents.

A somewhat unexpected result of work at the Marienau coke ovens had been that the good coke made under experimental conditions had not always been reproduced when the same process had been employed under commercial conditions. This, it was thought, was due to the difference between the care given to a research test and the conditions, including coal deterioration, which obtained in industrial coking practice. Good results, however, had been obtained from various blending experiments and by increasing the charging density, and, among other factors studied, had been dry and moist coal charges and the influence of oven width and of particle-size distribution within the charges. All of these factors had been found to have an influence on the quality of the coke produced.

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WELDING TECHNOLOGY

In the course of his speech when proposing the toast of the Institute of Welding at the Institute's annual dinner, held at the Park Lane Hotel, Piccadilly, London, on October 30, Sir John Cockcroft, K.C.B., F.R.S., spoke of the growing importance of welding in the nuclear-engineering field. He said that many difficult tasks in atomic-energy power stations and similar establishments had been undertaken successfully by welding engineers, and the fact that there had been no failures in the welds had engendered great confidence in the "welding fraternity." In return, radio-isotopes were being provided to the radiologist for the purpose of carrying out tests and similar work. Radio-isotopes, however, must be handled and used with care and he was glad, therefore, that a health and safety handbook had been issued for users of these substances. In conclusion, he congratulated the Institute on its new School of Welding Technology.

In reply to the toast, Sir Charles Lillicrap, K.C.B., the President of the Institute, also referred to the School of Welding Technology. He stated that they had received far more applications for the first course, held early in October, than they had been able to accept. Several subsequent courses were already over-full and it was quite clear that the response from industry to the Institute's new School was greater than they had hoped in their most sanguine moments.

RUBBER TO METAL BONDING

During the past few years Vacu-Lug Traction Tyres Limited, Gonerby Hill Foot, Grantham, have developed a method of bonding rubber to metal and, following a period of research and development, equipment has been installed which will make possible the reconditioning of solid tyres and other work on a larger scale than hitherto. The process is called Durasolid and it is stated that improved technique and materials have given excellent results in prolonged tests.

In addition to the reconditioning of solid tyres and the bonding of rubber to metal wheels, the rubber coating of hooks for lifting concrete pipes and of fan casings fitted to machines producing abrasive dust and particles, has been carried out. Other work has included the lining of pump casings handling corrosive liquids, the reconditioning of rubber-covered tracks fitted to half-track propelled vehicles and to lime spreaders, and the "rubberising" of rollers fitted to agricultural harvesting machines and industrial plant. In the last-mentioned application, rollers up to 6 ft. in length have been dealt with in this manner.

An interesting piece of work has been undertaken for a glass works, involving the building up of pneumatic-tyre rims to form solid tyres to replace the pneumatic tyres which are stated to have become rapidly unserviceable.

It is pointed out that all sizes of metal wheels or rims from 2 in. to 6 ft. in diameter can be rubberised or re-rubbered and upwards of 300 different sizes have already been treated. In addition to the smooth tread normally required for solid-rubber tyred wheels and rims, various traction-type patterns and designs can be produced.

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FILM ON LARGE STEEL FORGINGS

A sound colour cinema film produced by the English Steel Corporation Limited, River Don Works, Sheffield, 9, and entitled "Forgemasters in Steel," was shown in London recently.

The film runs for approximately 48 minutes and deals with the role played by the firm in the history of steel forging. Present-day processes, including some fine works views of steel melting and teeming and the casting of very large ingots and their subsequent forging, machining and testing, are then shown.

We are informed that the film wil lbe exhibited in various industrial centres throughout the country, including Manchester, Birmingham, Glasgow and Newcastle. As from January 1, 1958, it is planned to have copies of the film available for general release to clients, technical societies and colleges, and others desiring to borrow it for showing during the winter.

It is of interest to note that the film was accepted for showing at the Festival of Films in the Service of Industry, held at Harrogate from October 8 to 12.

BRITISH STANDARD FOR STEEL CASTINGS

Between 1935 and 1953 no fewer than 16 separate British Standard specifications for steel castings for general engineering purposes have been published; they deal with a considerable range of materials, varying from plain-carbon to high-alloy steels.

In reviewing the standards it became apparent that the general requirements clauses of each individual standard varied to a greater or lesser degree and it was therefore decided to co-ordinate them. The B.S.I. committee entrusted with this work has taken the opportunity to review the chemical compositions and mechanical properties specified in the specifications, and various amendments have been made to meet current practice.

The 16 specifications are now contained in a new comprehensive publication, B.S.3100:1957, "Steel Castings for General Engineering Purposes," and Part 1 consists of general clauses which are now common to all. The specific requirements for each material, mainly in tabular form, are contained in the second part of the publication.

The original numbers of each of the steel castings specifications have been retained so as to avoid possible confusion on existing drawings. There are three appendices, dealing in turn with "Procedure for Welding"; "Recommended Dimensions for Round Test Pieces"; and "Points on Which Agreement is Required Between Manufacturer and Purchaser."

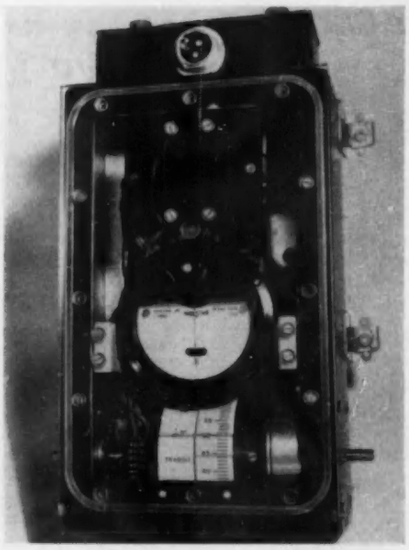
The publication contains 40 pages and copies are obtainable from the British Standards Institution, Sales Branch, 2 Park-street, London, W.1, price 7*s.* 6*d.*, post free.

Plant and Equipment

TESTING FIRING CIRCUITS

For testing firing circuits safely, the Weapons Division of the Fairey Aviation Company, Limited, Heston, Middlesex, have introduced a photo-electric ohmmeter, which uses a selenium photo-cell as the power source for a resistance bridge, thus eliminating the normal hazards involved in the testing of firing circuits. Explosive component checks rely on a measurement of resistance, which necessarily implies the application of electrical energy to the circuit. To remove the possibility of accidental ignition, the energy applied during the test must be below the safety margin of the component under any condition of instrument failure, or misuse. In conventional methods this is achieved by including a current or voltage-limiting device with the power source. In the event of a breakdown of this restraint, dangerously high currents can be introduced into the firing circuit, with a consequent risk of ignition. This danger is overcome by the use of a selenium barrier-layer photo-cell, the output of which, under any condition of light saturation or failure, cannot exceed a short-circuit current of 10 mA or an open-circuit voltage of 0·7V.

The instrument utilises a Wheatstone bridge, providing a range of resistance measurement from 0-10 kilohms in four switched ranges (0-10 ohms, 0-100 ohms, 0-1 kilohms, 0-10 kilohms). A "transit" position on the switch is arranged to place a short-circuit across the meter terminals for galvanometer damping. The power source for the bridge is a high sensitivity infra-red selenium photo-cell, the characteristics of which are modified in manufacture to limit the short-circuit current of the cell at light saturation, and yet maintain a high sensitivity at low illumination intensities. Null indication is provided by a sensitive centre-zero galvanometer, the pole pieces of which are shaped for off-balance insensitivity. To achieve a high accuracy and stability, ± 0·1 per cent. wire-wound resistors, cast in an Araldite block, are used for the bridge ratio arms, and a wire-wound cam-corrected potentiometer of ± 0·1 per cent. linearity for the variable element. To compensate for the ± 5 per cent. overall resistance tolerance of this potentiometer, a 5-ohm variable wire-wound resistance is included in the fixed ratio arm. This is accurately adjusted on initial assembly and locked.



A selenium photo-cell forms the power source of the resistance bridge of the Fairey photo-electric "safety" ohmmeter. The output from the cell cannot exceed a short-circuit current of 10mA or an open-circuit voltage of 0·7V, and thus eliminates any possibility of introducing dangerously high currents into the firing circuit.

The instrument consists of an inner sealed case, enclosing the bridge components, contained in an outer protective cover. The galvanometer and photo-cell are attached to the under-side of a Perspex plate which forms the lid of the inner case, and is hermetically sealed to it by means of a Neoprene washer. Cut-outs in the outer cover provide viewing access to the range and scale information, meter and photo-cell. To remove the possibility of accidental earthing of a test circuit by the instrument, the outer case is flame-sprayed with a tough durable coating of nylon. A connection to the instrument screen is provided for use if required. The range and scale drums are mounted adjacently and viewed through a single aperture. Control of the range switch and variable resistance is achieved by means of 3½ in. diameter knobs, the peripheries of which are fluted for ease of operation with gloved hands.

The fundamental bridge accuracy (determined by component tolerances) is of the order of ± 0·3 per cent. The measurement accuracy, however, is dependent upon the sensitivity of measurement and the scale reading accuracy. At low illumination intensities (i.e., below 50 ft.-candles), and under the load conditions presented by the bridge at any setting, the photo-cell is essentially a constant current generator. The current output, and therefore the sensitivity of the bridge, is directly proportional to the intensity of the light incident on the photo-cell. The illumination intensities required to produce a detectable galvanometer current for different range and scale settings are shown below.

Range	Percentage scale reading			
	5 per cent.	10 per cent.	50 per cent.	100 per cent.
0–10 ohms ..	9	5·5	3	2·7
0–100 ohms ..	2	1·3	0·8	0·7
0–1 kilohms ..	2·5	2	1·7	11·6
0–10 kilohms ..	13	12	12	12

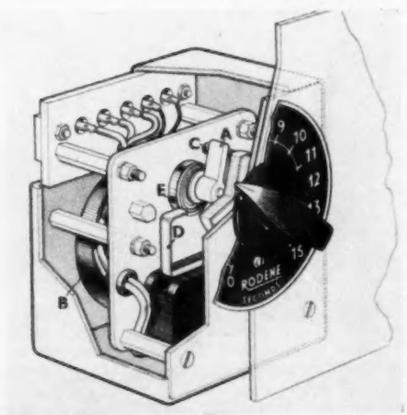
They are based on a ± 10 per cent. incremental change of the variable and are an indication of the measurement sensitivity of the instrument.

Using normal bridge-balancing techniques an improvement of at least 2 to 1 in bridge-setting accuracy can readily be achieved, since the figures quoted for measurement sensitivity relate to a detectable galvanometer deflection. Thus, the intensities given in the table are sufficient to provide a measurement accuracy of approximately ± 5 per cent. For higher accuracies, the illumination intensities should be increased proportionally. High scale reading accuracy is ensured by the use of a precision cam-corrected potentiometer, wired as a variable resistance, and an accurately graduated scale drum. This has an effective scale length of 6·5 in. for 100 divisions. The resistance angle of the potentiometer is held in manufacture to 300 deg. + 0 deg. − 0·25 deg., and the linearity to ± 0·1 per cent. Backlash is eliminated by fixing the scale drum directly to the potentiometer shaft.

A FLUSH-MOUNTING PROCESS TIMER

A new self-resetting synchronous timer has just been added to the Rodene range, made by D. Robinson and Company, 58 Oaks-avenue, Worcester Park, Surrey. It is designed for through panel mounting and, except for a small steadying screw, is one-hole fixing. It employs the instant-start, self-clutching Rodene timer motor which makes possible the method of operation shown below.

The spring marked E normally holds the arm A against the stop C which is positioned by the control knob. When the timer is switched on the arm begins moving counter-clockwise, the gearing in the motor being such that it takes the time indicated on the dial to reach the "O" position where it depresses the actuator D of a heavy duty micro-switch.



Automatic resetting is a feature of this process timer.

If the motor is now left energised it will come to a standstill, but will hold the switch operated. When the motor is switched off, its integral clutch opens allowing the spring to reset the switch immediately and restore the arm to its normal position against the stop ready for the next cycle.

There are four standard models, providing ranges of 0-15 sec.; 0-60 sec.; 0-5 min.; and 0-10 min. Due to the low stalled current and torque the first two models can be left "timed out" with the switch actuated for as long as required.

The two longer-period models each have a built-in relay arranged to reset the mechanism at the end of the timed period and to hold a contact operated during the "timed out" period.

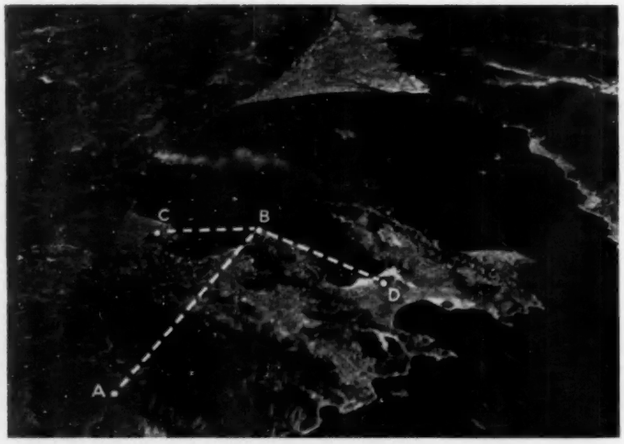
Behind-panel dimensions of the "seconds" timers are 3½ in. high by 3 in. wide by 3 in. deep. The "minutes" models are 3½ in. by 3 in. by 5 in. deep. The output switch has change-over action and is rated at 3 amperes at 450 volts a.c., and 5 amperes at 250 volts a.c. Motors are wound for most standard voltages and frequencies. Timing accuracy is very high as the motor always reaches synchronous speed in about two cycles.

Continuing **Plant and Equipment**

MICROWAVE LINK FOR RADAR

A surveillance radar system for Rongotai Airport, New Zealand, is to have a microwave radio link between the radar head and the airport control centre. Signals from the radar head terminal will be beamed to a hilltop overlooking Wellington and the airport. The illustration shows an aerial view of the Wellington area: A is the site of the radar head, B is the point at which the signal is split, C is Wellington City, and D is Rongotai Airport.

On the hilltop at B the incoming radar information is to be split by an aerial array, one portion being deflected to the airport itself to feed two fixed coil display units, the other being beamed to the Airways control centre in Wellington City, where four similar display units will be situated. One reason why a microwave link is being used in preference to a coaxial line is the fact that the region is prone to earth tremors. A distinct earthquake fault line can be seen running from the bottom of the illustration (to the left of A) diagonally to the top.



Signals from the radar head terminal (A) will be beamed to a hilltop (B) overlooking Wellington (C) and the airport (D).

The installation is to incorporate duplicate high-power radar equipments, type S264A, manufactured by Marconi's Wireless Telegraph Company, Limited, Chelmsford, Essex. The company have also been awarded the contract for the surveillance radar system at Ohakea Airfield, a busy Royal New Zealand Air Force operational base.

CREATING PETROLEUM PRODUCTS

The growth of the British chemical and petroleum industries may fairly be said to be the direct outcome of the policy of refining crude oil in consumer countries instead of in the countries where it is produced and, for this purpose, a wide range of highly efficient British plant and equipment has been developed. In these circumstances, the decision of the British Chemical Plant Manufacturers' Association and the Council of British Manufacturers of Petroleum Equipment to sponsor an exhibition devoted to the chemical and petroleum engineering industries will be generally welcome. It is being organised by F. W. Bridges and Sons, Limited, Grand Buildings, Trafalgar-square, London, W.C.2, and will be held at Olympia, London, W.14, from June 18 to 28, 1958.

Exhibitors will include firms which contract for complete refineries and chemical works, and firms which supply process plants for the production of heavy chemicals, fertilisers, explosives, coal-tar derivatives, petro-chemicals, fine chemicals and pharmaceuticals, paints, varnishes and plastics.

Concurrently with the exhibition, there will be a conference on "The Organisation of Chemical Plant Construction Projects," sponsored by the Institution of Chemical Engineers, 16 Belgrave-square, London, S.W.1. A number of film displays will also take place.

CLARIFYING COOLANTS

Grinding or honing coolants, of either the oil or the aqueous type, can be clarified continuously at throughput rates of up to 2,200 gallons per hour on the "Turbomatic" centrifuge, recently introduced by the Alfa-Laval Company, Limited, Great West-road, Brentford, Middlesex. Under exhaustive tests the machine has been shown to have an efficiency of 99·98 per cent. in continuous operation. The fractional percentage of solids remaining in the coolant consists of light material such as wheel bonding or fibre; these materials are in no way detrimental. Tests have also shown that centrifugal action has no harmful effect on coolants, which do, in fact, have their useful life extended greatly because of the improved cleaning.

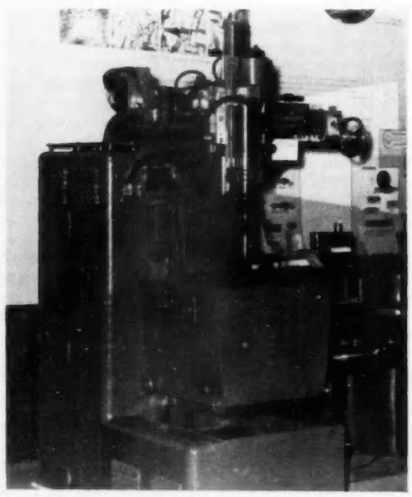
Continuous clarification of grinding coolant can be carried out at up to 2,200 gallons per hour on this Alfa-Laval centrifuge.

The machine has a large-capacity inclined centrifugal bowl, running at 1,450 r.p.m., and fitted with a large disc pack to give high-efficiency separation. It is driven by a 5 h.p. electric motor mounted directly above it. Extracted sludge builds up on the bowl wall, from which it is thrown down into the sludge trough when required. This ejection is achieved by the rapid "braking" of the bowl by means of a current-reversing switch. The sludge capacity of the bowl is 4 gallons, and only under exceptional conditions would ejection be necessary more than twice a day. Removal of the sludge from the trough, which forms the base of the machine, is done about once a week.

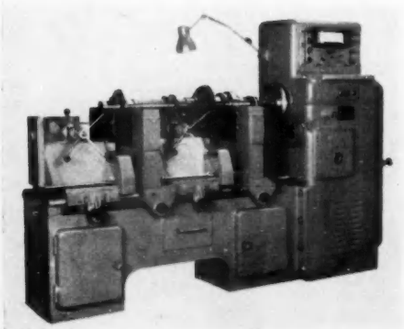
In view of the fact that the use of a centrifuge for grinding coolants may be considered rather revolutionary, the manufacturers are prepared to loan machines for test purposes where necessary.

SOVIET PLANT

RESEARCH and automation are two words associated in their separate ways with the future of engineering. Research depends on measurement, and automation on mechanisms that dispense with human labour. The following illustrations show Soviet equipment for testing or measurement and for automatic or simplified production. Most items have been designed and built by Soviet research establishments.

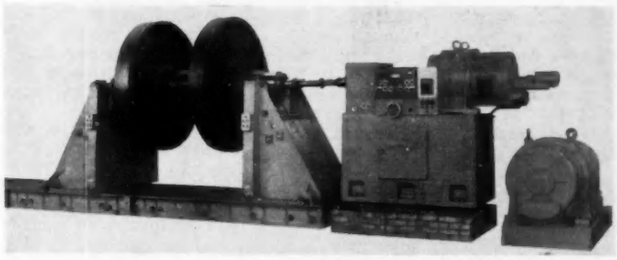


Universal spark erosion machine, Elektrom 12, for automatic copying of a soft-metal master, designed by the Soviet Academy of Sciences. Rectified alternating current at 50 cycles and 220/380 volts is used for working, and the total power consumption is 5 kW. With resistance-capacity circuit the metal removal is 180 and with resistance circuit 1,500 cub. mm. per minute. The machine dimensions are 820 by 1,350 by 2,070 mm. and its weight 1,200 kg. Metal removal is carried out in an oil bath, both to cool the workpiece and to prevent metal adhering to the electrode, which may be vibrated for extracting waste. The machine is capable of cutting a 17 micron diameter hole with an accuracy of 1 micron. Screw threads may be formed in tungsten alloys using a copper master.

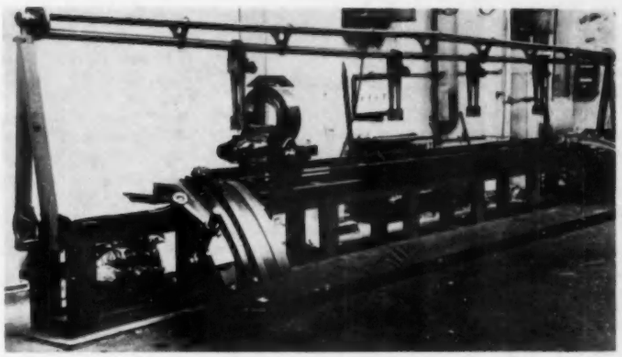


Balancing machine for lathe spindles, model 9B725A (Enims). The maximum weight of balanced parts is 100 kg., with a rotational speed of balancing from 900 to 1,600 r.p.m. The residual unbalance is stated to be 1 to 6 gm. cm. The overall motor power is 3 kW, and the weight of the complete machine 1,000 kg.

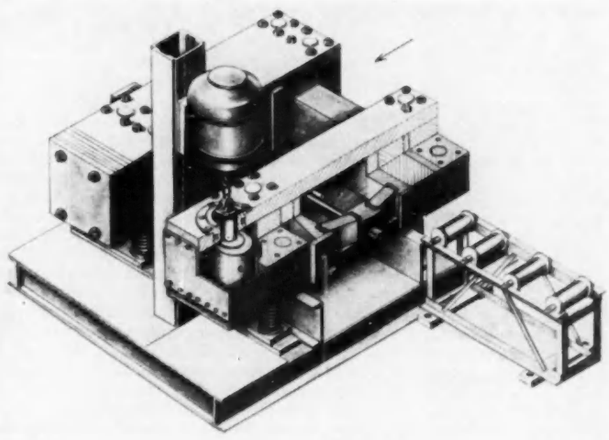
—TESTING AND AUTOMATIC EQUIPMENT

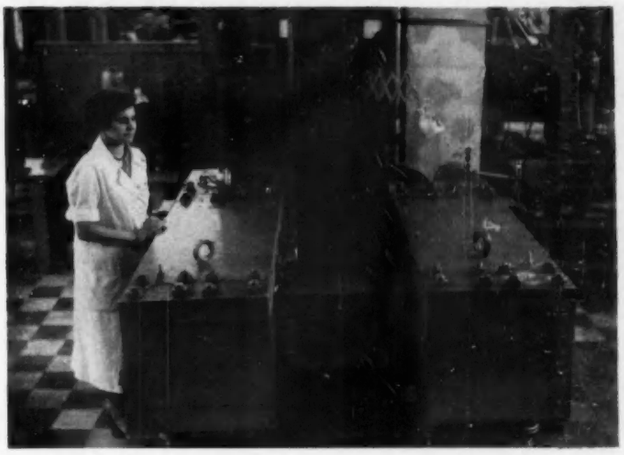


Balancing machine for workpieces weighing not more than 16 tons, model 9736A (Enims). The maximum diameter of workpiece is 3,200 mm. and the maximum length 6,300 mm. A Soviet balancing machine illustrated on page 442 of our issue of October 4 automatically applies metal by sparking to counter the unbalance.

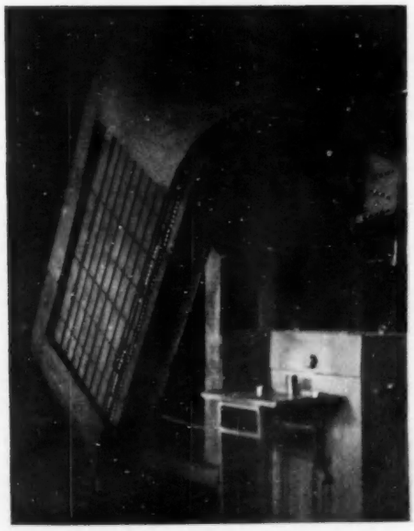


Automatic insulation winding machine developed by the Electrosila factory, Leningrad. Designed for large generator windings, the unit employs a rotating taping mechanism which passes along a carriage way. The long conductor is supported by hanging tongs, which open in turn to allow passage of the taping unit.

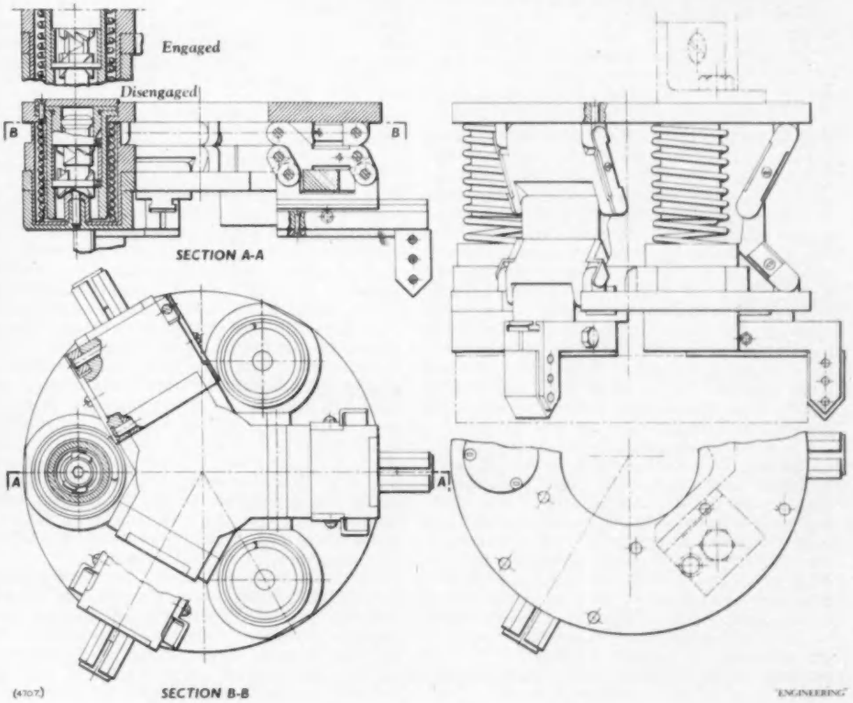




(Above and right) Machine (UP-200) developed and used by the Soviet Central Scientific Research Institute for Technology and Machine Building (TsNIITMash) for testing fatigue in alternate bending of sections up to 200 mm. thick. The institute is concerned with the development of rolling mills among other plant.



The study of automatic production occupies an important place in current Soviet applied research. A floating store for bearing races (above) serves as a buffer between two machines in an automatic production line at the First State Bearing Factory, Moscow. At Enims, the machine-tool research institute, a complete automatic line has been built for experimental purposes. The line includes a simple automatic component lifting device (right) developed and made at the institute.



Management

Weekly Survey

Advertising in the Country

New advertising regulations are being drafted by the Ministry of Housing and Local Government for the better control of outside advertising—a subject of major interest to the side of the engineering industry making durable goods. The Minister, Mr. Henry Brooke, told the Council for the Preservation of Rural England that he intends to tighten up the rules under which advertisements may be displayed on business premises. It will be made easier for the planning authorities to refuse consent to some signs of this nature, and it will also be made more clear that permission is needed for free-standing or portable signs. The Minister also anticipates an extension of the "special control areas" where general commercial hoardings will be banned and other types of outdoor advertising more strictly controlled.

The new plans have brought immediate and sharp protest from the advertising industry. The secretary of the Outdoor Advertising Industry Advisory Committee, Mr. H. H. Mallatratt, described the scheme as unworkable and "fantastic" and has predicted that within five years the planning authorities would be so overwhelmed by applications for legal consent that they could not possibly cope with the flood. Protest by advertising sources is understandable, since the industry as a whole, particularly the outdoor agencies, have had mixed fortunes over the past year. It may well be, in fact, that the new regulations will merely bring more sharply into focus the present recession in outdoor advertising. In that case the Ministry's plans may well be a mixed blessing, for a bare hoarding is even less pleasing to the eye than a glaring—but colourful—advertisement. Although the advertising industry cannot suppose that it has *carte blanche* to spoil the natural beauty of the countryside, in general their privileges have not been abused, and the great majority of hoardings in the countryside are sensibly positioned. In view of this, it is to be hoped that the powers conferred by the proposed regulations will be used as they are intended to be—intelligently and flexibly.

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Taxation and the Free Trade Area

The Federation of British Industries has issued a report called *Taxation in the Proposed Free Trade Area*. The occasion of this report has been the need for undertaking close study of the factors governing the comparative competitive power of industries in different countries in a free trade association. To-day, taxation is a useful fiscal device for achieving many ends of policy. Some of these are an aid to industry and some of them are the reverse. It is clearly necessary for those responsible for negotiating the clauses of a Free Trade Area convention to be aware of the impact of taxation systems in other countries and to know where and at what points those systems are used as a means for granting preferences, subsidies and rebates.

The report summarises the taxation structures of Austria, Belgium, Denmark, Finland, France, Western Germany, Italy, the Netherlands, Norway, Sweden and Switzerland. Taxes affecting trade and industry are discussed under five headings—taxes on income or profits, on capital, on sales or turnover, taxes based on the size of a payroll or number of workers employed, and local as opposed to national taxes. There are some important differences in these structures which hint at probably even greater diversity in the minutiae of taxation administration. In Germany and Belgium there is differential treatment of retained profits in favour of distribution. In Denmark there is differential treatment in favour of non-distribution. In most countries it would appear that the depreciation allowance and provision for stock valuation act on the whole in such a way as to keep the real capital employed in a business intact. On the other hand, the provision for losses is not generous on the whole which probably acts as a brake on the development of young enterprises while the creation of standing charges by capital taxation and taxes on payroll probably militates against flexibility of undertakings.

★ ★ ★

Lower Steel Tariff

On the face of it, the decision of the British Government to lower steel tariffs over a wide range of steel products from levels varying between 15 and 33⅓ per cent. to one not exceeding 10 per cent. is an inexpensive gesture. There may be more implications of principle for the future of free trade in western Europe, however, than at first meet the eye. At the moment the demand for steel in this country exceeds supply and the steel industry here still has a cost advantage over its Continental competitors. In such circumstances, the cut in tariffs can have little effect on the prosperity of the domestic steel industry.

If some current trends in steel develop, however, the picture may be less reassuring. There are already signs that steel production is catching up with demand and even more signs that the differential between cost of production of steel on the Continent and in this country is closing. These trends could point to a day when competition from the Continent in an area of free trade could seriously affect the United Kingdom steel industry. Further, much of the cost differential between here and the Continent has been due to low coal and steel-scrap prices. The day may come when a Free Trade Area may channel both these products into a Continental market which will pay higher prices and, if this happens, the cost advantage of British steel will have virtually disappeared.

On this occasion, therefore, when there is a tendency for us to congratulate ourselves on achieving a major diplomatic gesture at little expense it behoves us to remember that free trade appeals much more to industry in a seller's than in a buyer's market. Last week's gesture by the Government on steel tariffs may one day look an exceedingly dangerous thin edge to an unpleasant wedge if a steel surplus develops.

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Boom Tomorrow?

It is now general knowledge that the hoped-for American up-turn in industrial activity this autumn has not arrived. Interest is now passing from that fact to some estimate of whether there is going to be a serious downward turn of some duration or a recovery next spring. The timing of the trend in the United States is now all-important for the rest of the world. While consumer spending is set at a high level in the United States, thus preserving western Europe's export market right through the summer, the failure of industry as a whole to expand its turnover has led to a serious decline in commodity prices which will have to be reversed fairly soon if those countries which export commodities are not to start cutting back their imports. There are valuable markets along the tropical belt which cannot take the present level of rubber, cocoa and copper prices for many months without serious decline in their prosperity.

The latest organised exercise in crystal gazing in the United States comes from the semi-annual meeting of the Department of Commerce's Business Advisory Council. This consists of 100 businessmen, and a group of this size is perhaps ill-conceived as a means of venting opinions on the finer shades of economic forecasting. Nevertheless they seem to have been fairly well agreed that industrial activity is going to decline in America until sometime in 1958. Their opinion is that the decline will be gradual following a period of sustained activity but that the up-turn will not come before the middle of next year. With the American economy poised between a boom in consumer spending and extreme caution in the capital goods industries (a situation reminiscent of this country at the moment), the authorities find themselves in a cleft stick. If they prick the bubble of consumer spending and its inflationary potential by maintaining their current restrictive credit policy they may hasten the decline in the capital goods industries. If they relax credit terms too quickly they may stimulate consumer spending and so encourage an inflation which they have set out to liquidate. This is the dilemma which the United States Administration finds itself in and which suggests that things may drift further before decisive action is taken. It is this drift which American businessmen fear and which is reinforcing their caution, a caution which may bode ill for the rest of the world if it lasts too long.

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Dollars in Deutschland

American interest in German industry is growing. One sign of this is the increasing number of American companies that have moved their European offices from Paris to Düsseldorf or Frankfurt. The actual total of American capital invested in German industry is about 150 million dols. This is modest enough compared with the amounts invested in Britain. Nevertheless, co-operation between American and German concerns is growing. For example, the American companies with contracts in India for building the Tata steel mill and for an oil refinery in Colombia have placed big orders for components in Germany. Big orders for oil tankers for America have been placed in Hamburg.

This growing industrial power of Germany has attracted considerable attention in the United States. Returning service men have helped to spread the idea that Germany alone of the West European countries has the necessary capacity and urge to expand. The expansion of the German steel industry from scratch to over 22 million tons a year since the war, and the increase of 23 per cent. in heavy-machinery production in the past year support this view.

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Machinery and Shift Working

Attention has been drawn over the last week or so by two different sources to the importance of working more than one shift on expensive modern machinery. Speaking to the North Midlands Regional Cost Conference of the Institute of Cost and Works Accountants recently, Mr. W. Coutts Donald drew attention to the need to think in terms of higher machinery productivity as well as higher labour productivity. He claimed for multiple shift working that it considerably reduced financial outlay on capital equipment, improved quality in continuous processes and improved the spreading of the power load and achieved useful economies in heating costs.

The latest issue of the Treasury Bulletin for Industry draws attention to the marked difference in the proportion of workers on shift work in the United States compared with the United Kingdom. Only 12 per cent. of operatives in manufacturing and public utilities are on shifts in this country. In America the proportion is very much higher, perhaps double, where the working population is now prepared to adapt its meal times and shopping habits to the shift system. The Treasury Bulletin draws attention to the value of increased shift working as a means of attaining a higher rate of output when capital investment is limited.

Marketing

ENGINEERING FIRMS IN THE FREE TRADE AREA

12—RÉGIE NATIONALE DES USINES RENAULT

In assessing the effects of the coming Free Trade Area on individual companies, the prospects for an efficient motor manufacturer must be considered promising. Total imports of motor cars into the countries likely to constitute the Free Trade Area have doubled since 1950 and it has been suggested that by 1970 trade in automobiles between the participating countries may increase to as much as five times the present level. The motor car has progressed from being an expensive luxury to what Sir William Rootes recently described as an " economic and social necessity." In 1956, for example, there were nearly 4 million private cars in use in the United Kingdom, representing a four-fold increase since the war, and nearly twice the 1950 total. Yet the number of persons per car was still as high as 13. The fact that in the United States there is one car to every three persons gives some idea of the potential size of the future market for cars. On the Continent, Austria (37 people per car), Belgium (17), Denmark (18), Finland (39), Holland (33), Western Germany (25) and Norway (26) all offer even larger potential markets. There were 14·5 million passenger cars in use in Europe in 1956, representing an increase of 20 per cent. over 1955, and over 8 million more than before the war. Table I shows how far production to meet this demand has been expanded by the major European producers in recent years.

On the purely economic side, it is apparent that with the large increase in trade predicted when the Free Trade Area proposals are adopted, the necessity for commercial travelling by business men will rise sharply. The train and the aeroplane are, of course, the answer to very long distance travelling, but once on the Continent the business man can move fast and efficiently on the new motor highways. In addition, there will of course be a rapidly expanding demand for commercial transport by road. From the " social " viewpoint, the demand for smaller cars is also likely to expand rapidly, both as a result of the general increase in the standard of living and of the gradual elimination of import tariffs. In the light of future prospects, the setbacks experienced by many motor manufacturers in 1956, particularly in the United Kingdom, must be regarded as a short-term reversal. They can in no sense be treated as a vindication of the criticisms that have been heard in some quarters of over-exuberant expansion plans.

The Régie Nationale des Usines Renault of Billancourt is keenly aware of the potentialities of a Free Trade Area in Europe and is well prepared to meet the challenge, particularly in the field of small cars. The company spent £154 million on new plant and equipment during the ten-year period ending in 1956, including £10·7 million for a two-mile long assembly plant at Flins and £25 million in tooling up for the production of the popular " Dauphine " family car. The government-owned Renault concern has 10 plants in France and seven in other countries. In addition they have shareholdings in other companies which were valued in 1956 at approximately £4·4 million. Their interests include 12 companies in the French Union and six foreign subsidiaries. They are the biggest motor manufacturers in France, employing 57,000 and accounting for over 33 per cent. of French vehicle output. In Europe, Renault's 1956 output of 219,000 private cars was beaten only by Volkswagen (362,000), Fiat (262,000), the British Motor Corporation (246,000) and Ford's (227,000). In addition, Renault are of growing importance in the field of commercial vehicles, of which they produced over 45,000 in 1956. The company also produces petrol and Diesel tractors, industrial engines, machine tools and railway rolling stock.

Renault have maintained a leading place in the export market for vehicles, and 54,030 private cars were sent abroad in 1956, which represented a 17 per cent. increase over 1955, and accounted for about 25 per cent. of total production. The company claims it accounts for 45 per cent. of total French vehicle exports. What is more important from the viewpoint of the Free Trade Area is that Renault's exports to other European countries represented over 70 per cent. of their total sales abroad. By comparison, barely one-quarter of United Kingdom cars sold abroad go to European destinations. Table II shows how firmly the major car producing countries on the Continent are entrenched in intra-European trade.

The relative advantages and disadvantages of specialisation by individual manufacturers is one on which there has been a good deal of controversy. Specialisation on one or two successful models can obviously help to reduce production costs substantially, but at the same time such specialisation greatly increases the risk to the producer if a particular model proves less popular than that of a competitor. The British motor vehicle industry has in the past tended to play for safety by producing a multiplicity of models and has, on occasion, proved vulnerable to competition from European producers when the latter have succeeded in producing a popular car on a large scale at a reduced price. The advantages of specialisation are likely to be considerably enhanced when the Free Trade Area is formed in view of the very large potential market which will arise.

Renault are an excellent example of a company which has consistently and successfully pursued a policy of specialisation. Despite their size, Renault have had sufficient faith in their future to narrow their range of basic private car models to only three types: the 2,141 c.c. " Fregate " saloon priced at £907 in France, and the two smaller family models, the 845 c.c. " Dauphine " (£565) and the " 4 C.V." 750 c.c. model (£407). Renault developed the small light car primarily for the French market, where heavy taxation on motoring encourages the demand for a small cheap car. They have, however, found a ready market for both the 4 C.V. and particularly the Dauphine in foreign markets.

It is these light cars which are likely to be a particularly profitable source of income in the coming years. Even without the possibilities thrown open by the Free Trade Area, a car which will sell at around £450 to £500 and run at 50 miles to the gallon fills a need which exists in most markets. In response to the demand for a good lightweight car, production of the Dauphine in 1956 rose sharply to 78,136 units, while output of the 4 C.V. totalled 112,050 units.

Concentration at the Renault organisation means that not only are few basic models produced but that the concern's other interests are sternly relegated to a secondary place in their activities. Of Renault's sales, 85 per cent. are accounted for by motor cars and commercial vehicles. For example, Renault also produced tyres, but two years ago ceased their manufacture in order to concentrate their efforts on vehicles.

The company is also concentrated in its structure. It is a largely vertical concern and has its own foundry which is said to produce half its steel needs. Renault make many of their own highly automatic machine tools. This latter development was an outcome of the immediate post-war years when, with an acute shortage of tools and an output barely exceeding 12,000 vehicles a year, Renault was forced to design and build its own machine tools. The large and complex transfer machines which have been developed and made by the company have helped in the construction of up-to-date assembly lines at Flins which, it has been suggested, are in many ways ahead of Detroit in construction and performance. Indeed, Renault have a thriving sale of machine tools to other companies, and in 1956 their turnover in machine tools, including transfer machines, totalled Frs. 530 million (£500,000).

Renault are also strongly placed, in view of their well developed subsidiaries, for local assembly and sale in other countries, for which many of the materials are bought locally. In the United Kingdom, for example, where Renault Limited assemble cars near London, over half the company's material requirements are purchased in Great Britain. In 1956, 1,716 Renault cars assembled in this way were sold in the United Kingdom. In other European countries, the Société Espagnol des Automobiles Renault sold 5,392 vehicles in 1956, while Renault Automobile Gesellschaft für Deutschland sold 3,558 cars last year. In Belgium 2,919 cars were sold through the Agence Belge des Automobiles Renault, and sales of the Swiss subsidiary, S.A. pour la Vente des Autombiles Renault en Suisse, amounted to 2,821 vehicles.

Well equipped as they are for the future, Renault fully realise that they are not the only company in Europe competing for the light car market. In the class of vehicles which gives a high mileage per gallon at a low price the Volkswagen must of course be regarded as a

TABLE I.—*Western Europe: Passenger Car and Chassis Production by Major Producing Countries*, 1951-1956 (000)

	U.K.	W. Germany	France	Italy
1951	476	267	320	119
1952	452	301	370	114
1953	595	369	371	143
1954	769	518	444	181
1955	898	705	561	231
1956	708	909	663	280
Percentage increase, 1956 compared with 1951	+49	+243	+198	+135

TABLE II.—*Western Europe: Exports of Passenger Cars and Commercial Vehicles (Complete and Chassis) by Major Producing Countries*, 1951-56 (000).

	United Kingdom		W. Germany		France		Italy	
	Total	Of which to W. Europe*	Total	Of which to W. Europe*	Total	Of which to W. Europe	Total	Of which to W. Europe
1951	369	15	91	75	93	37	29	62
1952	310	21	100	75	83	42	25	78
1953	302	21	138	78	81	44	30	80
1954	366	27	231	75	101	43	41	68
1955	373	20	320	66	133	48	69	65
1956	337	23	413	60	151	49	78	70
Percentage increase (+) or decrease (−) 1956 compared with 1951	−9	—	+352	—	+63	—	+169	—

* Austria, Belgium, Denmark, Finland, France, W. Germany, Greece, Iceland, Italy, Leichtenstein, Luxembourg Netherlands Norway, Portugal, Spain Sweden, Switzerland.

Continuing **Marketing**

serious competitor, though it is in a slightly bigger class than the smaller Renault cars. A little heavier than the Dauphine, the Volkswagen de Luxe has a higher rated capacity (1,192 c.c. as against 845 c.c.) and is somewhat longer. The fuel consumption is also rather higher than that of the Dauphine (45·2 m.p.g. as against 52·0 m.p.g.). The buyer who wants a car which is slightly heavier than the Dauphine, however, finds the Volkswagen a good purchase at a price which is some £25 cheaper. Despite this price differential, Renault have high hopes that the Dauphine may eventually supplant the Volkswagen in the lead of foreign cars on the competitive United States market. Considering how short a time the Dauphine has been on the market in comparison with its German rival, the French car has had a conspicuous success in the United States, sales totalling 7,344 models in the first half of 1957. They are still however a long way behind Volkswagen, who sold over 31,000 cars in the United States in the same period. Volkswagen G.m.b.H. are fully aware of the extent of the competition they have to face in this and other markets, and have shown no sign of faltering in their steady expansion. In 1956, their output rose by nearly 20 per cent. to 395,690 vehicles, of which nearly 218,000 were exported. Volkswagen sales to other European countries accounted for over 50 per cent. of their total exports last year. Meanwhile they are continuing their successful policy of ploughing back a high proportion of their earnings for capital expansion and to this end invested a further £13 million in 1956.

In the slightly lighter class, Fiat are the most serious competitors. The Fiat 600, weighing 11¼ cwt. and with a rated capacity of 633 c.c., has approximately the same petrol consumption as the Renault 4 C.V. (53·3 m.p.g.) but is £5 cheaper than the French car. Compared with the Dauphine the Fiat 600 is less powerful but has a lower petrol consumption and is considerably cheaper. The Fiat 500 is smaller and cheaper still and meets the demand for a 2-cylinder car with a fuel consumption of the order of 60 m.p.g. Renault are not really represented in this class, although they are rumoured to be considering the development of a " bubble " car. Fiat are very similar to Renault in that they produce only one large car and concentrate mainly on two basic light car models. Their output is however higher than that of Renault. Fiat employ 75,000 workers and produced 262,000 vehicles in 1956, which accounted for more than 90 per cent. of total Italian private car output. Of this total nearly 30 per cent. was sent abroad, again mostly to European countries. Large and concentrated as they are, the Italian Fiat concern must be regarded as a strong competitor in the small car market of the future.

If Renault decide to develop a still smaller car than their present models, this might help the company in the competition which they have experienced from Citröen as their most important competitor in many ways. The popular Citröen 2 C.V. weighs 10½ cwt., has a rated capacity of 425 c.c. and has only two cylinders compared to the four of the Dauphine and Renault 4 C.V. While necessarily less powerful than the Renault cars, the Citröen 2 C.V. has two important points in its favour. One is the extremely low fuel consumption (68·7 m.p.g. is claimed) and secondly that it is some £40 cheaper than the Renault 4 C.V. The immense popularity of the " Deux Chevaux " in France can be gauged from the fact that at present the French customer has to wait three years for delivery of a new Citröen 2 C.V. Citröen, who are France's third largest motor manufacturer (after Renault and Simca) had an unsuccessful year in 1956, converting a net profit of Frs. 1,014 million in 1955 to a net loss of Frs. 814 million last year. Nevertheless, Citröen produced 130,000 cars in 1956 and have a very high export ratio. Their merger with Panhard in 1955 makes them a formidable opponent in the small car market.

What of Britain's chances in this profitable field? In the field of small lightweight cars the outlook is not very promising. The United Kingdom car industry, besides being very well placed in the field of larger cars, has virtually no rival in the field of sports models and when tariff barriers are lowered should do well on the Continent with these types of cars. Tariff barriers against imported cars are high in European countries, as is shown in Table III, and few Continental companies can match British prices and performance in the field of larger cars and sports models. Indeed, paradoxically, the market for larger cars may eventually be bigger on the Continent than in this country, bearing in mind the present state of road congestion in the United Kingdom.

TABLE III.—*Western Europe: Import Duties on Motor Cars by Major Importing Countries*

Benelux	24 per cent.
Denmark	Kr. 0·35 per kg.* on cars under 1,600 c.c. Kr. 0·55 per kg.* on cars over 1,600 c.c.
Norway	30 per cent.
Sweden	15 per cent.
France	30 per cent.
W. Germany	16 per cent.
Italy	45 per cent. on cars up to 1,500 c.c. 40 per cent. on cars between 1,500 and 4,000 c.c. 35 per cent. on cars over 4,000 c.c.
United Kingdom	30 per cent.

* Equivalent to between 25 and 30 per cent.

No United Kingdom manufacturer has, however, really tapped the small car market in which Renault, Citröen and Fiat have had so many years of experience. There is indeed a big demand for cars of this type in Great Britain. Figures of new registrations for 1956, for example, show that 99,309 cars below a rated capacity of 1,000 c.c. were registered last year, accounting for nearly 25 per cent. of total registrations. In 1955 new registrations of cars of this type were even higher, at 30 per cent. of the total. It was probably due only to temporary fiscal and hire purchase restrictions that the demand fell off slightly in 1956. The credit squeeze, which also hit business buying, did not force companies to go as low as 1,000 c.c. in the search for smaller and cheaper cars, although in the range 1,100 to 1,200 c.c. the proportion of new cars registered in 1956 was 26 per cent. as against just over 21 per cent. in the previous year.

In the class of cars under 1,000 c.c., the Austin A35, Morris Minor and Standard 10 (all 948 c.c.) and the Standard 8 (803 c.c.) have hitherto claimed large sales in the United Kingdom. The fuel consumption of the Standard 8 is low (58·3 m.p.g.), but it would lose on price to the lighter Renault 4 C.V. and the Dauphine if trade barriers were eliminated. The price at present charged to visitors to the United Kingdom (who do not have to pay the United Kingdom tariff) for the imported Dauphine is £419 (excluding purchase tax) while the 4 C.V. is priced at £360 on the same basis. The Standard 8 on the other hand has a current price (excluding purchase tax) of £452. The Austin A35 at £379 (excluding purchase tax) would be some £20 more expensive than the Renault 4 C.V. on a tariff-free basis. The Morris Minor is very popular in this country, but has a slightly higher fuel consumption than the French models and would be only slightly cheaper, at £416, than the Dauphine. In view of these considerations the British motor industry must expect greatly increased competition at this end of the market when trade barriers are removed.

The logical answer for the British industry might be to follow the example set by their Continental competitors and specialise. The two largest British companies, B.M.C. and Ford, have an average of six basic models each. This is high compared with the average of Volkswagen, Renault and Fiat of only three basic models. It is in the field of the large car and the sports model that specialisation would appear to offer the best prospects for the British industry.

Table III shows that, with the exception of West Germany, where import duties are considerably lower than in the other countries concerned, there is not a great deal of difference between the tariffs imposed by European countries which are important producers of motor vehicles. The overall effect of a removal of tariff barriers must therefore be considerably to improve the competitive position of foreign manufacturers in each individual market. The effect of this will be to increase substantially the potential market available for each type of car. Since there is every reason to anticipate a steady expansion in the total European market for cars, the risks inherent in specialisation may be expected to be reduced and the greatest success may well be achieved by those manufacturers who are the first to build up a reputation in a relatively narrow field.

* * *

MORE PLASTICS SOLD

Sales of plastics materials continue to expand, and totalled 196,000 tons in the first half of 1957. This represented a 13 per cent. increase over the second half of 1956 and over 19 per cent. above the first half of last year. Provided the industry receives no major setbacks in the closing half of 1957, it seems likely that sales could reach 400,000 tons this year which is well on the way to the annual target of 500,000 tons. This prosperity is being shared by nearly all branches of the industry. Only sales of casein plastics showed a marked fall in the first six months of this year, amounting to 900 tons as against 1,400 tons in the first half of the preceding year. The most marked increases were again in Polythene (over 40 per cent.), polystyrene (12 per cent.) and polyvinyl chloride (over 30 per cent.).

In response to the increased demand for thermoplastics, the major manufacturers in the United Kingdom are expanding capacity fast. At Hillhouse, Imperial Chemical Industries Limited have completed the extension of p.v.c. capacity where production is being steadily expanded to its maximum potential of 55,000 tons. By the end of 1957, total United Kingdom capacity of p.v.c. should reach 88,000 tons per annum, made up of the production of I.C.I., British Geon Limited (27,000 tons) and Bakelite Limited (6,000 tons). I.C.I. are also engaged on the next stage in the expansion of their Polythene plant at Wilton, which is expected to raise their capacity of this material to 40,000 tons by the end of 1958. Meanwhile, the 12,000 ton Polythene plant of the Union Carbide Company, Limited, at Grangemouth, is due to start production this month. This, together with I.C.I.'s capacity and other plants building by Monsanto Chemical Company, Limited, British Hydrocarbon Chemicals, Limited, and Petrochemicals Limited, should bring total United Kingdom Polythene capacity to over 100,000 tons per annum by the end of 1958. Expansion plans are also in hand for the production of Polystyrene by Monsanto, Styrene Products Limited and British Resin Products Limited. It remains to be seen if these schemes are going to be modified owing to higher interest rates.

Interest in the expansion of the use of plastics is not by any means confined to the United Kingdom. United Kingdom exports of plastics continue to rise and in the first half of this year totalled 52,000 tons, an increase of nearly 20 per cent. compared to the first half of 1956. Strong competition from abroad must, however, be expected to grow. In Germany the Chemische Werke Huls is planning the erection of a large-scale plant for the manufacture of Polythene by the Ziegler low-pressure method, while in Italy Edison and Union Carbide have recently merged to form a new company " Celene," for the production of Polythene, the initial annual capacity to be 10,000 tons. These are only two examples of the increase in foreign competition to be expected in the future. Further afield, Japanese production of polystyrene is expected to exceed 1,500 tons per month by September, 1958, and a polystyrene plant in India with an annual capacity of over 5,000 tons commenced production recently. In view of the worldwide interest in plastics expansion, it is apparent that the United Kingdom industry must fight hard to maintain and increase its share of export markets.

Research and Development

BURSTING STRENGTH OF GLASS DISCS*

TESTS AT ATMOSPHERIC AND ELEVATED TEMPERATURES

By P. L. Thorpe and D. Dawson, G.I.MECH.E.

This investigation was undertaken at the instance of a manufacturer of toughened glass, Tudor Safety Glass Company, Limited, Kentish Town, London, N.W.5, who required information on which to base the design of boiler water-level glasses. In making ordinary plate glass, the final annealing treatment removes any internal stresses induced in the glass in the course of manufacture; in making toughened glass, however, compressive stresses in the surface layers are deliberately induced by a special heat treatment, and in consequence the strength of the glass in bending is considerably augmented. Moreover toughened glass, when it fractures, breaks up into characteristic granular particles, and these are far less likely to cause personal injury than the larger acicular pieces into which annealed glass shatters. The toughened glass was supplied to the Laboratory in the form of flat discs—some 3 in. and others 12 in. in diameter, and of several thicknesses. In addition, at the authors' request, the manufacturers supplied similar discs of annealed glass for comparative tests.

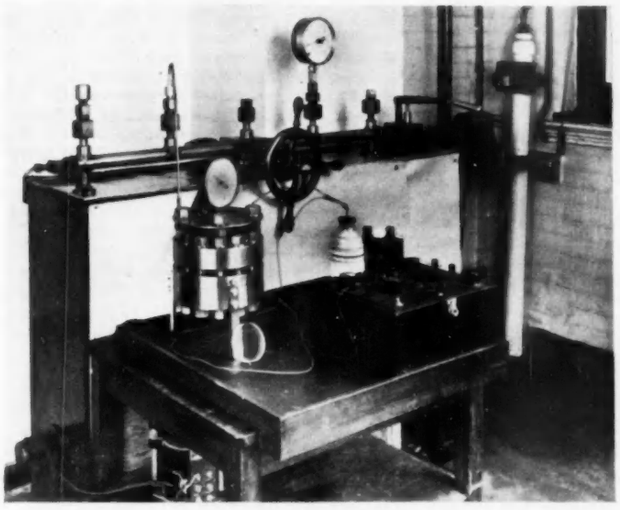
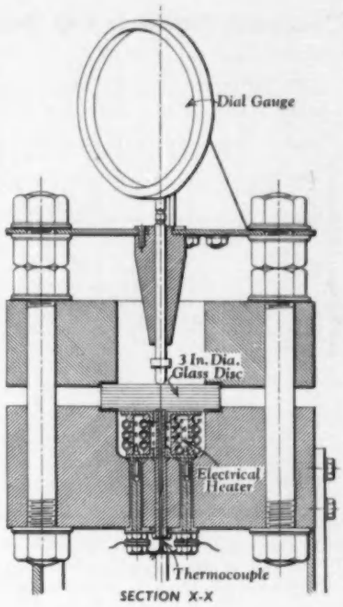


Fig. 1 (right) Pressure vessel for testing 3 in. dia. discs.



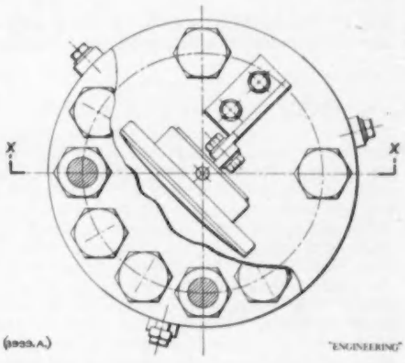


Fig. 2 (left) Apparatus arranged for tests on a 3 in. dia. disc.

TEST APPARATUS

The apparatus used was designed and constructed at the National Physical Laboratory. The assembly used for the tests on the 3 in. diameter discs is shown in Fig. 1. It consists of two steel flanges, slightly recessed to accommodate the glass disc which is clamped between them; asbestos fibre rings $\frac{1}{16}$ in. thick are interposed to distribute the clamping load evenly over the glass. The flanges are held together by 12 steel bolts, uniformly spaced round the periphery, and these bolts are tightened to a definite tension by means of a calibrated torque spanner. The upper flange consists of a simple ring, so that the upper surface of the disc under test is open to the atmosphere; the lower flange is solid but is further recessed in the centre, and pressure is applied to the under surface of the disc under test by oil pumped into the recess. The recess is also made deep enough to accommodate an electric immersion heater; the temperature at the underside of the glass being measured by means of a thermocouple held lightly in contact with the glass. The deflection of the disc at its centre is measured by a dial indicator mounted above the top flange. The general arrangement is illustrated in Fig. 2, which shows also the pump, intensifier and calibrated pressure gauge by which the pressure is adjusted and measured. The apparatus used for the tests on 12 in. discs was similar except for one detail noted below.

CLAMPING CONDITIONS

In the 3 in. apparatus the inside diameter of the upper ring flange and the diameter of the recess in the lower flange is $2\frac{1}{4}$ in., and this of course is the effective diameter over which pressure is applied. The edges of the disc are thus held over an annulus $\frac{3}{8}$ in. wide, but the degree of clamping attained depends not only on the ratio of this annular width to the thickness but also on the compressibility and shear rigidity of the asbestos-fibre jointing rings. These characteristics of the jointing rings depend upon the clamping pressure applied in bolting up.

In the 12 in. apparatus the jointing ring is $\frac{1}{2}$ in. wide so that the effective diameter of discs tested in this apparatus is 11 in. Since the jointing ring in the 12 in. apparatus is relatively so much narrower by comparison with the disc diameter than in the 3 in. apparatus, the clamping is on that account less complete. However, it will be seen from the results of tests described below that the degree of clamping is so much reduced by the elasticity of its jointing rings that the effect of the width of the ring is scarcely discernible.

TABLE I.—*Results of Pressure-Temperature Tests on 3 in. dia. Toughened and Annealed Glass Discs*

Condition of glass	Thickness of disc	Test temp., deg.C.	Bursting pressure of disc, lb. per sq. in.	Maximum deflection at centre of disc	Estimated clamping pressure, tons per sq. in.
	In.			In.	
Toughened	1/8	20	300	0·006	10
,,	,,	20	560	0·015	10
,,	,,	20	355	0·009	10
,,	,,	20	470	0·012	10
,,	,,	100	400	0·010	10
,,	,,	100	470	0·015	10
,,	,,	150	430	0·012	10
,,	,,	150	350	0·010	10
Toughened	3/8	20	5,300	0·009	50
,,	,,	20	5,500	0·010	50
,,	,,	20	6,700	0·012	50
,,	,,	20	6,300	0·009	50
,,	,,	100	5,900	0·013	50
,,	,,	100	5,400	0·012	50
,,	,,	100	4,800	0·010	50
,,	,,	100	6,800	0·013	50
,,	,,	150	5,500	0·014	50
,,	,,	150	5,300	0·012	50
,,	,,	150	6,100	0·012	50
Annealed..	3/8	20	1,330	0·005	5
,, ..	,,	20	1,920	0·007	10
,, ..	,,	20	1,650	0·005	10
Toughened	5/8	20	>13,400	>0·015	50
,,	,,	150	>6,000	>0·004	50
Annealed..	5/8	20	2,700	0·003	10
,, ..	,,	20	1,900	0·002	10

TABLE II.—*Results of Pressure-Temperature Tests on 12 in. dia. Toughened and Annealed Glass Discs*

Condition of glass	Thickness of disc	Test temp., deg.C.	Bursting pressure of disc, lb. per sq. in.	Maximum deflection at centre of disc	Estimated clamping pressure, tons per sq. in.
	In.			In.	
Toughened	3/8	100	147	0·15	4
,,	,,	150	145	0·13	4
,,	,,	200	130	0·12	4
Annealed..	5/8	20	90	0·02	4
,, ..	,,	20	80	0·01$_5$	4
,, ..	,,	20	95	0·02	4
Toughened	5/8	20	320	0·10	4
,,	,,	20	320	0·09$_5$	4
,,	,,	20	330	0·09$_5$	4
,,	,,	20	380	0·11	4
,,	,,	100	320	0·10	4
,,	,,	150	310	0·09	4
,,	,,	200	380	0·10$_5$	4
,,	,,	300	380	0·08$_5$	4
Toughened	1	100	1,250	0·08	12
,,	1	150	1,280	0·08	12
,,	1	200	1,265	0·08	12

* Communication from the National Physical Laboratory.

Continuing Research and Development

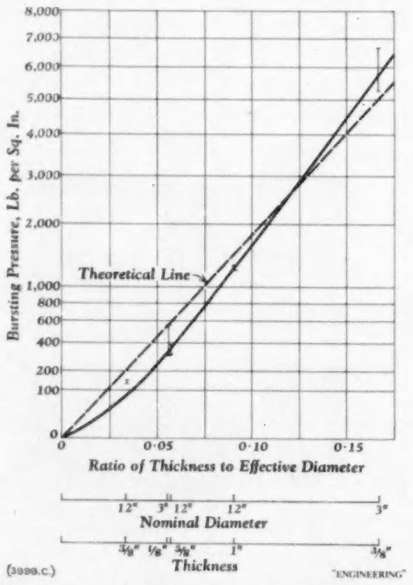


Fig. 3 Toughened glass discs. Relation between bursting pressure and ratio of thickness to diameter.

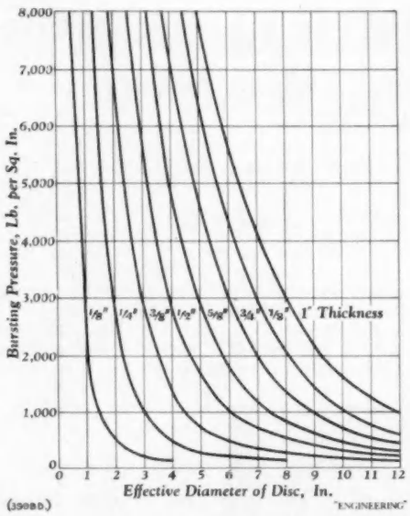


Fig. 4 Toughened glass discs. Estimated bursting pressure.

RESULTS OF TESTS

In the first series of tests the pressure on each disc was increased at a steady rate until failure occurred; measurements of central deflection only being recorded at each increment of pressure. The rate of increase of deflection with pressure was practically constant and the slopes of the pressure-deflection lines for the toughened glass were substantially the same at all temperatures from 20 deg. C. to 300 deg. C. (no tests at elevated temperature were made on the annealed glass). The results of all the tests made are listed in Tables I and II. The clamping pressures stated in these tables represent the average pressure on the joint ring exerted by the known tensions in the bolts corresponding to the torque applied to them in tightening up; fairly high clamping pressures had to be used in order to prevent leakage of oil past the jointing ring at the underside of the glass discs.

From Tables I and II it will be seen that the strength of the toughened glass discs was unaffected by temperature up to 300 deg. C. The method of heating from one side only was deliberately adopted in order to simulate working conditions, and it had been expected that the steep temperature gradients both through the thickness of the glass and from the centre to the edges of the disc on its upper surface might result in thermal stresses and thus influence the strength. From the results it seems that no appreciable tensile stress at the centre of the upper (free) surface of the disc can have resulted from the thermal gradients. Presumably these gradients were so closely uniform that no appreciable thermal stresses were set up.

Since the discs were virtually elastic up to failure the principle of geometrical similarity ought to apply, and the bursting pressure should depend only on the ratio of the thickness to the effective diameter, except in so far as the clamping condition may vary both with the ratio of the width of the jointing ring to the thickness and with the pressure applied over this ring. Moreover if the clamping condition were invariable, and if failure were determined merely by the maximum tensile stress set up, the bursting pressure should be proportional to the square of the ratio of the thickness to the effective diameter. In Fig. 3 the square root of the bursting pressure (lb. per sq. in.) is shown plotted against the ratio of thickness to diameter. The relationship is not quite linear but by comparison with the scatter within the individual groups of tests, on the same size of disc, the deviations from the single curve drawn are not significant; and in particular there is no evidence of appreciable difference of clamping condition, neither between discs of the same diameter and several thicknesses nor between discs of the two diameters tested in the two different rigs. The slight curvature of the line drawn in Fig. 3 is in the opposite sense to that which would be expected to result from variation in clamping condition, in so far as the thicker discs would be expected to be less well clamped. The curvature is probably associated with the greater difficulty of ensuring uniform clamping round the periphery of the thinner discs, and the higher clamping pressures applied to the thicker ones. The curve shown on Fig. 3 has been used as a basis to construct the design diagram, Fig. 4; but of course in applying this diagram to design, normal factors of safety should be allowed. Photographs of typical fractures of annealed and toughened glass discs are reproduced in Fig. 5.

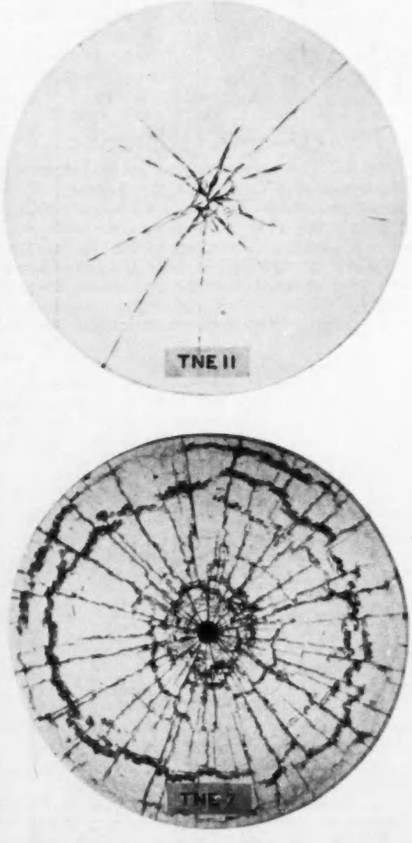


Fig. 5 12 in. dia. glass discs after testing. Upper figure, annealed glass; lower figure, toughened glass.

TENSILE STRESS IN DISCS UNDER PRESSURE

Although the measurements of bursting pressure described above sufficed for the primary purpose, the apparent insensitivity of the discs to clamping condition pointed to the need for more detailed information regarding the state of stress in the discs under pressure. For this purpose resistance-wire strain gauges were glued to the upper surfaces of 12 in. discs of the three thicknesses, namely $\frac{3}{8}$ in., $\frac{1}{4}$ in. and 1 in. In the principal series of tests three gauges were attached to each disc, one at the centre and two along radii, one close to the edge and the other midway between the edge and the centre, as shown in Fig. 6. In a subsidiary series of tests, measurements were also made of the circumferential strain. This strain had everywhere the same sign as the radial strain; at the centre the two strains are of course identical; near the edge the circumferential strain was about half the radial; and at the intermediate gauge position the two strains were roughly equal. In computing the radial stress f_r from the radial strain e_r by means of the formula

$$f_r = \left\{\frac{E}{1-\sigma^2}\right\}(e_r + \sigma e_\theta),$$

the circumferential strain e_θ has been taken equal to e_r at the centre and at the intermediate position and equal to $\frac{1}{2}\,e_r$ at the outermost gauge. These ratios were not precisely preserved throughout but the deviations were so slight that errors due to this inaccuracy are quite negligible. In any case the maximum stress at the centre is always $\frac{E\,e}{(1-\sigma)}$. The value of Young's modulus E was determined by static bending of a flat strip and checked by measurement of elastic wave velocity of an ultrasonic pulse; the two measurements agreed closely and yielded the value $E = 10{\cdot}5 \times 10^6$ lb. per sq. in., and the ultrasonic measurements also gave the value $\sigma = 0{\cdot}226$ for Poisson's ratio. Both toughened and annealed glasses were almost completely isotropic.

The variations of radial stress with pressure for the three thicknesses of disc are shown in Fig. 7, where the pressure scales have been made proportional to the squares of the thicknesses in

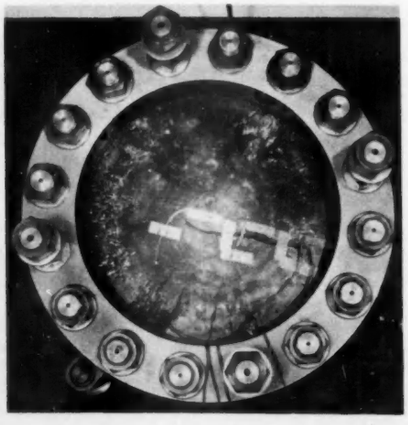


Fig. 6 Strain gauges affixed to 12 in. dia. toughened glass disc.

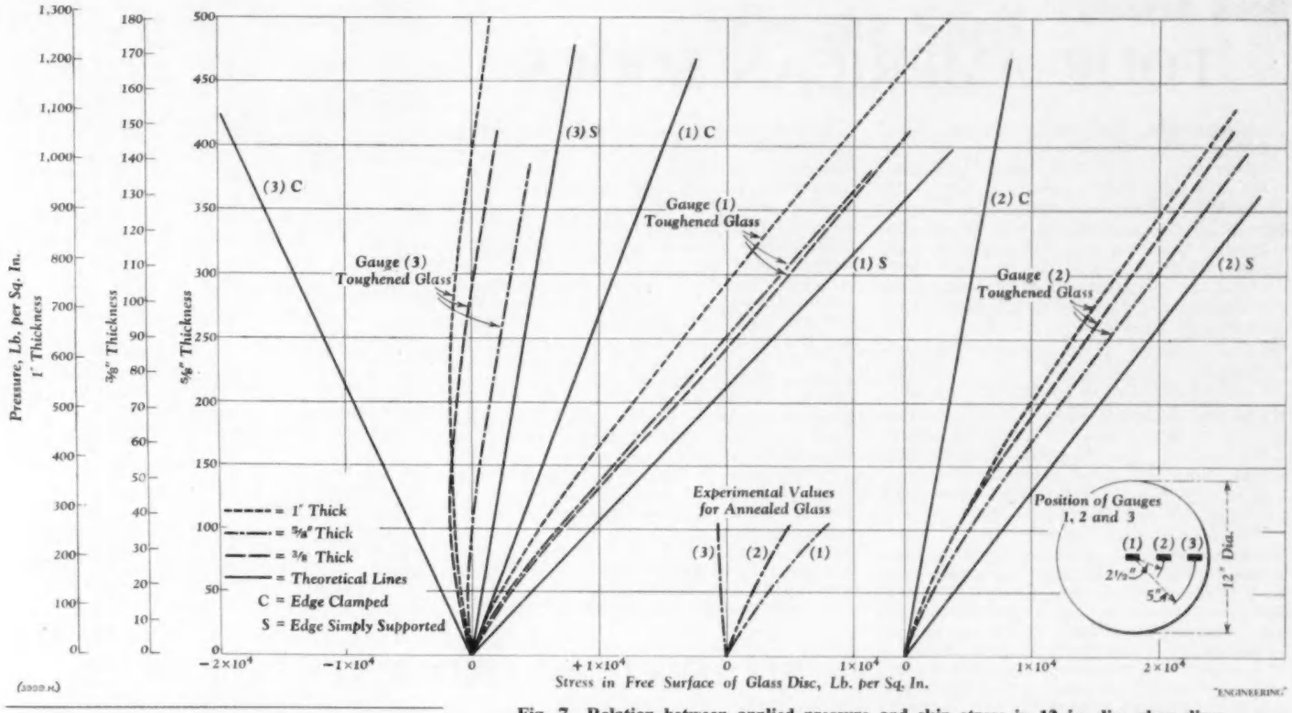


Fig. 7 Relation between applied pressure and skin stress in 12 in. dia. glass discs.

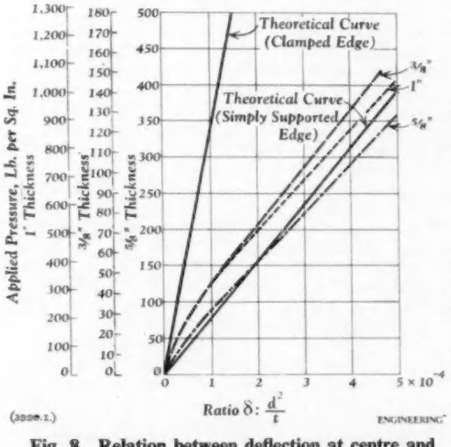


Fig. 8 Relation between deflection at centre and applied pressure, 12 in. dia. toughened glass discs.

order that the individual curves may be directly compared. On the same diagram the theoretical lines for edges simply supported and edges clamped* are also shown. By comparison of the experimental curves with the theoretical straight lines it will be seen that at very low pressure the edge condition approximates to perfect clamping; but that the curves very soon bend away from the clamped edge lines and over most of their lengths they run practically parallel to the lines corresponding to the condition of simple support. The degree of clamping achieved was slightly better for the ⅝ in. disc than for the ¾ in., as would be expected, because the ½ in. width over which both discs were secured is relatively greater for the thinner disc. However a higher degree of clamping was in fact achieved in the 1 in. disc. In the test on the 1 in. thick disc, in order to prevent oil leakage past the jointing ring on the underside, it was found necessary to increase the clamping pressure from 4 tons per sq. in., which had been used in the tests on the two thinner discs, to 12 tons per sq. in. It is apparent from Fig. 7 that this increase in clamping pressure overweighs the reduction of relative width of jointing ring.

In Fig. 8 the measured deflections of the three discs are compared with the theoretical values for clamped and simply supported edges. For any given condition of edge restraint the stress in the disc is proportional to $p\left(\frac{d}{t}\right)^2$, and the deflection is proportional to $p\left(\frac{d^4}{t^3}\right)$, where p is the pressure, d is the diameter and t the thickness of the disc. In order to permit direct comparison, the stresses in Fig. 7 have therefore been plotted against values of $p\left(\frac{d}{t}\right)^2$. In adopting the same scale of ordinates in Fig. 8, the appropriate scale of abscissae is then the ratio of the deflection δ to $\left(\frac{d^2}{t}\right)$. As in Fig. 7 the experimental curves tend at very low loads to follow the theoretical line for clamped edges, but they very soon depart from this line and approach the line for simply supported edges. The experimental readings of deflection include the compression of the upper asbestos jointing ring itself under the applied pressure. Allowance for this extra deflection would need to be made before the experimental curves could be compared in detail with the theoretical lines, and if this allowance were made it is probable that the corrected curve for the ¾ in. disc would lie above the line for simply supported edges. However, the fact that this curve lies well below the other two confirms the indication, afforded also by Fig. 7, that the clamping of this disc was less effective than in the other two tests. The maximum tensile stresses developed in the three discs of toughened glass were 33,000 lb. per sq. in. in glass ⅝ in. thick, 31,000 lb. per sq. in. in ¾ in. glass and 38,000 lb. per sq. in. in 1 in. glass; the maximum tensile stress developed in annealed glass ¾ in. thick was about 7,900 lb. per sq. in.

Acknowledgments.—The investigation described above was carried out at the request of the makers of the glass (Tudor Safety Glass Company, Limited) who have kindly given their consent to the results being published. Permission to publish this paper has also been given by the Director of the National Physical Laboratory. The authors desire to acknowledge the valuable help and advice rendered by Mr. H. L. Cox, M.A., and the assistance of Mr. D. L. R. Bailey, B.Sc., in the earlier section of the work.

* S. Timoshenko "Strength of Materials" Part II D. van Nostrand Co., Inc. 2nd Edition: page 139.

A PIPE AS REPLACEMENT FOR TELEPHONE WIRES

At a recent exhibition, "Telecommunications, Past, Present and Future," presented by the London Centre of the Institution of Post Office Electrical Engineers, a low-loss microwave link was shown by Elliott Brothers (London) Limited, Boreham Wood, Hertfordshire. The system is still in the development stage. Basically it is proposed to transmit radio waves with a frequency of 35 kMc/s (8 mm. wavelength) for long distances through a straight circular tube, or waveguide. The tube causes the waves within it to retain a certain configuration, and by correct design a wave mode is achieved that gives a very low rate of signal attenuation. Waves in this mode—it is called the H_{01} mode—have an attenuation of about 4 dB per mile at 35 kMc/s. It is essential that the pipe be straight and where corners have to be turned the mode has to be changed. The microwave division of Elliott Brothers suggest that it would be an advantage to operate the system at a frequency of 75 kMc/s, when the loss should be about 2 dB per mile. Theoretically, use of such extremely high frequencies allows about 2 million telephone channels to be carried down the tube.

The performance of the system is not critically dependent on the surface finish of the tube, which is of copper. To modulate such frequencies with speech, a ferrite is used to rotate the plane of polarisation of the signal. For the modulation process, the microwaves are vertically polarised. The amount of rotation corresponds to the intensity of the speech signal. By passing the wave containing the new horizontal and reduced vertical components through a filter that removes the horizontal ones, an amplitude-modulated vertically polarised wave is obtained. The wave is then transformed into the H_{01} mode.

Book Reviews

FOUR AMERICAN BOOKS

Thermodynamics. By VIRGIL M. FAIRES. Third edition. *The Macmillan Company, 60 Fifth-avenue, New York 11, N.Y., U.S.A.* (7·50 dols.); and *The Macmillan Company, New York, 10 South Audley-street, London, W.1.* (52*s.* 6*d.*)

Elementary Thermodynamics. By VIRGIL M. FAIRES. Third edition. *The Macmillan Company, 60 Fifth-avenue, New York 11, N.Y., U.S.A.* (6·75 dols.); and *The Macmillan Company, New York, 10 South Audley-street, London, W.1.* (47*s.*)

Thermodynamics. By FRANKLIN P. DURHAM. *Longmans, Green and Company, Limited, 6 and 7 Clifford-street, London, W.1.* (55*s.*)

Engineering Thermodynamics. By C. OSBORN MACKEY, WILLIAM N. BARNARD and FRANK O. ELLENWOOD. *John Wiley and Sons, Incorporated, 440 Fourth-avenue, New York 16, N.Y., U.S.A.* (8 dols.); and *Chapman and Hall, Limited, 37 Essex-street, London, W.C.2.* (64*s.*)

Thermodynamics is governed by two laws. A third law in the offing does not appear likely to have much effect on engineers. The first law merely states the equivalence of different forms of energy, but the second law is difficult to understand in many of its forms. Briefly, to an engineer, it means that an engine can convert only a limited proportion of a quantity of heat into useful mechanical work.

A convenient way of measuring the fraction of a quantity of heat unavailable for conversion to mechanical work is to use the concept of entropy. Entropy defies a ready understanding as it has no workaday analogy. The best thing to do is to use it in calculating thermodynamic cycles; after some practice, understanding will come unnoticed.

The second law is studied because from it can be derived concepts of ideal machines which use every bit of the available energy. The task of the engineer is to produce engines which approach the ideal as nearly as possible. And so modern text-books tend to contain more mathematics than older ones, and less practical engine details —some, indeed, contain none at all.

It is possible to base a personal philosophy on the second law. One expression of it taught in life, but not printed in text-books, is " Nothing for nothing and damn little for sixpence." Engineers may well accept a moral compulsion to make every sixpennyworth of natural resources yield the maximum they can get.

How should a student choose one of the four American text-books which are the subject of this review? A good way would be to select the one which gives the best treatment of the second law and the concept of entropy, for if the student goes wrong on these there is no hope for him as a thermodynamist. Professor Faires wisely gives several statements of the law, separated by sentences of explanation, and persuades his reader that it is all very reasonable. The author is a talkative writer and his work is most readable. Much of the text appears to have been taken from a well-tried work published under a different title, but there is no suggestion that the present books have been brought up to date by merely appending chapters on later developments. The new material has been grafted on to the old to make a logical, fluent text-book.

There are many illustrations in Professor Faires' books, a large proportion of them being pitifully small and indistinct. There is, for example, a cross-section of a large jet aero-engine darkly illustrated in a few square inches. This tells the reader so little about an intricate and complicated machine that it would be better left out. The diagrams are also too small and overcrowded with symbols. The fussiness of the graphical material is the worst fault of these two books.

By carving chapters out of *Thermodynamics* Professor Faires produced *Elementary Thermodynamics*. The mathematical treatment is at the same level, so it is difficult to see how the shorter book is elementary—but it is too narrow in scope for a final degree examination.

Professor Faires acknowledges help from the English department of a university in Texas. A British university would have despaired, but the British write a different sort of text-book. The American author seems always to be attempting a royal road to learning by writing in a brisk and racy style. It could be argued that this conceals what it seeks to reveal, and that the coldness of British text-books is more direct. Nevertheless, there are few British texts which could sustain a flagging interest as well as Professor Faires.

A text-book in the British style is that by Franklin P. Durham, presumably not yet a professor as the title page does not say so, but well qualified for promotion by his book. This is a wiry, lean sort of book. The text says what it has to say and moves on with purpose to the next point. The diagrams are big, simple and memorable, setting the standard of the book. There are numerous worked examples comparable with university examination questions in this country, and plenty of questions at the ends of the chapters. There are no illustrations; the book is not concerned with the practical aspect of heat engines, as is shown by the absence of a chapter on vector analysis of turbines. It is difficult to fault this book except for its restricted scope. It is clearly intended by the author to cover a certain American course, and should not be bought by a student in this country unless he has assured himself that it covers all his needs.

Professor Mackey's book gives generous treatment of a full course, except that it lacks a chapter on heat transfer. In spite of this, it is the best book of the four. The diagrams are clear but could be bigger. There are some illustrations to help the text along. The worked examples seem simple by English standards, as do the questions at the ends of the chapters, giving the impression that the text is unnecessarily advanced for the problems. This book is a good example of a modern text built up from a sensible blend of proved material on basic principles, and up-to-date writing on later developments.

This raises the question of why new text-books on thermodynamics are needed. The answer is largely in the development of gas turbines, which engines have developed so rapidly and are so important that to append a chapter or so to an existing text would not be good enough.

FLUID FLOW AND HEAT TRANSFER

An Introduction to Fluid Mechanics and Heat Transfer: With Applications in Chemical and Mechanical Process Engineering. By J. M. KAY. *Cambridge University Press, 200 Euston-road, London, N.W.1.* (37*s.* 6*d.*)

Principles of Engineering Heat Transfer. By WARREN H. GIEDT. *D. Van Nostrand Company, Incorporated, 120 Alexander-street, Princeton, New Jersey, U.S.A.* (8·25 dols.); and *D. Van Nostrand Company, Limited, 358 Kensington High-street, London, W.14.* (62*s.*)

Fluid mechanics is a difficult and complicated subject. Galileo said in 1638: " I had less difficulty in the motions of heavenly bodies, in spite of their astonishing distances, than in the movement of flowing water before our very eyes." Diligent work over the last 300 years has scarcely simplified it. Instead, the scope of fluid mechanics has expanded from the flow of water to the flow of anything at all responsive to the laws of particle mechanics. Almost anything can be pumped these days.

There are few applications of fluid mechanics which adhere closely to known natural laws expressible in absolute mathematical terms. Apart from Bernoulli's equation, the whole thing is empirical. Text-books are substantially devoted to justifying the results of painstaking experiments and emphasising the limits beyond which they should not be applied.

Osborne Reynolds and Froude made startling advances in the second half of the Nineteenth Century. Froude investigated surface phenomena in the design of ships and Reynolds produced means of predicting the flow through pipes. Dimensional analysis overcame trouble with units and made it possible to apply experience on models to the full-scale design.

Another great development due to Reynolds was his analogy between fluid flow and heat transfer. It is not a complete analogy, but the ideal is very elusive in this field and much good work has been based on it.

Hydraulics is an isothermal affair and energy was conveniently expressed as the equivalent static head. For heat effects in gas flow, it became necessary to add heat and work terms to the Bernoulli expression, and now it is usual to express energy as temperature head, a measure of the heat content.

Flying brought a fresh outlook on fluid mechanics. Up to the turn of the century practical solutions had been sought to problems of surface effects and flow in constraining envelopes. Aviation presents the problem of a body immersed in the fluid air. Aerodynamics, the new branch of fluid mechanics, made its own way until it returned to the main stream with the arrival of the gas turbine. For steam turbines, it was convenient to regard blading as a series of nozzles. Compressor blades are better thought of as aerofoils.

Flying presents problems in fluid mechanics and heat transfer as intractable as any in modern technology. Consider the heating effect of skin friction at high speed. How can an aircraft be made so that the rate of flow of heat from the skin into the airframe will allow an adequate flying time before the crew are overcome and the structure fails from overheating ?

In the process industries, the effectiveness of heat exchangers may dominate the profitability of a plant. The optimum design is the one which will exchange most heat for an acceptable pumping cost. The constant recurrence of these dual problems demands books dealing with them both together.

Professor Kay leads his student logically through fluid mechanics, takes up heat transfer on the way and then pursues the two together. The chapter on heat transfer through solids is brief and almost an aside. The method is abstract and as mathematically rigorous as could be desired. The presentation is formal, as in the majority of British text-books at this intellectual level. In the best sense of the word, the work is that of an amateur. For him, his subject is the thing and followed for its own sake; few references are made to the work of others. There is no concession to the idea of using the book as an aid to earning a living.

At the end of the book are 40 examples, presumably from examination papers. They are mostly expansive questions covering the basic specification of a piece of equipment—questions which, outside the examination room, are the responsibility of chief designers. No solutions are offered. Essentially, it is a book for two sorts of students—those who study for the sake of the thing or to teach others, and those who study for examination.

Professor Giedt's book covers roughly the same ground, but is markedly more interested in heat transfer. Fluid mechanics is a regretted necessity. The author does, in fact, hint in his

preface at teaching the subject without any fluid mechanics at all, an idea to which Professor Kay would be unlikely to subscribe.

This American book has clearly heard the great American question " What's in it for me ? " This is no work for the arid intellectual or the dilettante. It is a go-getter's guide to success in heat transfer. It is also for the examination candidate who will pass or bust.

Professor Giedt justifies most pages with an abundance of references, and acknowledgments to contemporary work. There are lavish illustrations of apparatus and graphs of experimental results, showing each one of hundreds of observations. Problems follow each chapter. Short, direct, earthy questions are presented as they would be encountered daily by any technician in a design office or on a plant. No answers are given.

There are comparatively few books of any sort on fluid mechanics and heat transfer. The arrival of two which are not only good but also complementary is therefore doubly welcome.

CONTEMPORARY PRINCE

Selected Speeches 1948-1955 by His Royal Highness The Prince Philip Duke of Edinburgh. *Oxford University Press, Amen House, Warwick-square, London, E.C.*4. (12*s.* 6*d.*)

In his autobiography the Duke of Windsor recalls the misunderstanding which arose as a result of an innocent remark he made during his visit to a colliery at the time of the slump and mass unemployment. The monarch—that incident seems to show—should keep to a well-defined but narrow range of topics in public speaking. Prince Philip is not the monarch, but he could easily have caused much embarrassment in the past few years if he had not been gifted with that flair for moving in the limelight with grace and assurance which distinguishes his family. Here, in this book, is a record—the first of many, it is to be hoped—of his first years of public speaking.

Of the fifty speeches included, a dozen or so were to scientific or engineering bodies, and several of the others, though addressed to non-technical organisations, touched on scientific matters. Addressing the Staff College, Camberley, in 1954, he sought to correct the impression that science " should only be handled at the very top level . . . or possibly with bated breath in the Service Ministries." He expressed it this way: " In fact, of course, scientists and science can and do cope with problems at all levels so long as they find people at all levels able to understand what they are getting at. It is obviously more rewarding to discuss improved infantry weapons with a company commander who has fought in Korea than with, let us say, a general who was at Balaclava. But if that company commander does not understand what the scientist is trying to do there will be no significant progress either." Only a man who has experienced the rough and tumble of Service life at a junior level, seen the brilliance and the woodenness of the human mind, and acquired a greater depth of understanding than many of his contemporaries, would think of expressing that idea. The Apple Cart was not upset since King Magnus would have made a better politician than any of his ministers; science, not politics, would claim Prince Philip—but preferably engineering science because engineering is human as well as technical.

★ ★ ★

NEW BOOKS

Physics of Non-Destructive Testing. British Journal of Applied Physics, Supplement No. 6. *The Institute of Physics, 47 Belgrave-square, London, S.W.*1. (25*s.*)

The contributions published in this Supplement to the *British Journal of Applied Physics* are selected from those presented at recent meetings of the Non-Destructive Testing Group of the Institute of Physics. They include most of those read at a conference held in Bristol in July, 1956, and are reprinted in the order in which they were presented. The purpose of the Supplement is to enable engineers, metallurgists and others concerned with non-destructive testing to appreciate the importance of the new methods and to indicate how far the physical behaviour of materials under various conditions can be utilised and developed into methods for non-destructive testing.

Mechanical Engineering. By R. W. STEED. *Robert Hale Limited, 63 Old Brompton-road, London, S.W.*7. (8*s.* 6*d.*)

Intended to help careers masters, mistresses, parents and boys and girls in the choice of a career, a series of books, entitled " Targets for Careers," has been published. One of the first in the series is Dr. Steed's book on *Mechanical Engineering*. He groups the subject under five general headings, namely: the types of mechanical engineering; the grades of mechanical engineers; their training and qualifications; the prospects in mechanical engineering for the different grades; and tabulated information concerning leading university colleges and colleges of technology and the training schemes organised by various companies. There are also data on the opportunities for women in mechanical engineering and on the training and employment of overseas students in the United Kingdom.

Electrical Engineering. By D. O. BISHOP. *Robert Hale Limited, 63 Old Brompton-road, London, S.W.*7. (8*s.* 6*d.*)

The " Target for Careers " books, of which the present volume is one, are intended to help careers masters, mistresses, parents and boys and girls in the choice of a situation by explaining in simple language what certain positions in industry entail and what they have to offer. After a brief survey of all the subjects dealt with by electrical engineers, from electric power generation, transmission and utilisation, to telecommunications and electronics, the author briefly describes the different types of posts available. He then explains in detail the training and education required by craftsmen, technicians and professional electrical engineers and technologists and states how this training is acquired.

Aluminium in Shipbuilding. *The British Aluminium Company Limited, Norfolk House, St. James's-square, London, S.W.*1.

The technical suitability of aluminium alloys for marine work is an established fact, as our own columns have borne witness. The present publication is a revision of one issued in 1955 and describes recent developments in jointing techniques. It includes also a new series of extruded sections designed especially for marine applications. The recommendations made in the publication are based on the extensive practical and experimental work carried out by the aluminium industry and by various official and commercial organisations. A bibliography on the subjects dealt with is included.

Economic Development: Theory, History, Policy. By GERALD M. MEIER and ROBERT E. BALDWIN. *John Wiley and Sons Incorporated, 440 Fourth-avenue, New York* 16, *N.Y.* (8.50 *dols.*); and *Chapman and Hall Limited, 37 Essex-street, London, W.C.*2. (68*s.*)

The authors of this book examine the problems involved in accelerating the economic development of poor countries and of maintaining the development of rich ones. They set out to explain the forces that give long-period growing power to a nation's economy. In the second of the book's four parts, they examine the historical rôle of Britain as the centre of Nineteenth Century world economy, concentrating on some features of the extensive spread of development throughout the world economy during that period. In addition to the hundreds of references in the text, there is a 12-page bibliography of books and articles recommended for further study. A high proportion of these items are British.

On the Shelf

By Frank H. Smith

There are certain trade names that are inseparably associated with a particular type of product, usually because those names were the pioneers or among the pioneers in the field. If this is not quite clear let me quote, as an example, Bakelite in the field of plastics. There was a time when any plastics article was loosely referred to as Bakelite by the uninitiated and I am reminded of this by a profusely illustrated booklet by that company showing a few of its applications. The booklet is called *Plastics Review*, and it can be obtained from the firm at 12 Hobart-place, London, S.W.1.

I wish I could read Dutch but even the fact that I cannot does not prevent me from appreciating that a new aeronautical journal from the Netherlands called *Aviatiek* contains good material. Further particulars are obtainable from 12 Plantage Parklaan, Amsterdam. The subject, by the way, is transport and not that of wavy lines round an aerofoil.

Last year, the Cornell Aeronautical Laboratory, Cornell University, Buffalo 21, U.S.A., completed 10 years of existence and a commemorative booklet *A Decade of Research*, 1946-1956, has been issued describing the inception of the project and some of the research that has been undertaken. This covers the whole field of aeronautics and a chapter tells of the library needed to help the researchers. Some of the brain food provided comprises 7,000 textbooks, 500 periodical subscriptions, and 115,000 reports, and there may be some significance in the fact that while the books have increased from 3,000 and the periodicals have doubled in the ten years of the library's existence, reports have increased sevenfold. Among the treasures given as being in the possession of the library is one of the eight complete sets in the United States of the *Journal of the Royal Aeronautical Society*.

International Alloys Limited, Haydon Hill, Aylesbury, have produced a rather handsome book (though of an awkward shape for any shelf, namely, 9 in. high by 12 in. long) celebrating 25 years of progress. A short account of the company's activities is followed by the (inevitable) photographs of products, processes and shops and, right at the end, is a folded data sheet of the aluminium casting alloys produced by the firm. I suspect (though I do not know) that this last can be obtained as a separate item. If it can, it should be the most useful item of the book and the one most likely to be retained on an already crowded shelf.

The Seventh General Assembly of the Advisory Group of Aeronautical Research and Development is to be held in Washington from November 25 to 26. This means that delegates will arrive from all over Europe for just two days' discussion, at some expense, presumably, to their governments. One of the items is a round-table discussion on " Towards Higher Altitude." A difficult subject on which to get down to earth.

The Aluminium Development Association has issued a new edition of its " List of Publications." I have always had a soft spot for the A.D.A. staff at 33 Grosvenor-street, London, W.1, because I have always found them most co-operative and willing to help if they possibly can. One cannot say this of all similar bodies where, quite often, before anything is done one has to claim membership of the association.

Galitzine and Partners, of 17 Victoria-street, London, S.W.1, have issued, on behalf of the Compagnie Universelle du Canal Maritime de Suez, a five-page booklet, *Suez: Egypt's Debt*. This is an appraisal of the effect of the canal's nationalisation in terms of £ *s. d.* and the question of the importance of adequate compensation is discussed.

The Story of B.O.A.C. 1956-57—*a Year of Development* is a talkie-talkie version of the B.O.A.C. Annual Report. It is, of course, full of hope and promise and pictures of Comet IVs and Britannias.

From two different sources I have received Bulletin No. 11 of Edward Stanford Limited, 12-14 Long Acre, London, W.C.2. The name Stanford, of course, is synonymous with the making and sale of maps.

Design

COMBINING TWO TYPES OF POWER IN A SINGLE VEHICLE

By D. A. Jones, B.SC., PH.D., A.M.I.E.E.

The paper describes vehicles which use two forms of energy for propulsion. The aim being to obtain the advantages of both modes of propulsion without any of the limitations of either. A petrol-electric and a battery-electric combination are discussed in detail. The present change in the availability of various fuels is considered and it is suggested that a vehicle which is adaptable to various forms of stored energy may have much to commend it, even if its initial cost is high.

Rail and road transport have conventionally used one of the following means of motive power:—

(*a*) Coal-fired steam engine.
(*b*) Petrol or Diesel engine and gearbox.
(*c*) Petrol or Diesel-electric.
(*d*) Straight electric.
(*e*) Battery-electric.
(*f*) Gyro-motive.

Sometimes the choice of motive power for a particular transport system is obvious but often the reasons may be justifiable locally but not nationally. For example it would appear that in about five years time there will be a possibility of a world shortage of light Diesel fuel, mainly due to the increasing use of jet engines. Table I shows some of the limitations of each mode of motive power.

TABLE I.—*The Limitations of Conventional Motive Power*

Motive power	Limitations
Coal-fired steam engine	Very inefficient—heavy.
Petrol or Diesel engine and gearbox	Engine has to be large enough to cope with maximum required torque, and very seldom runs at its maximum efficiency. Poor torque at low speeds.
Petrol or Diesel-electric	Heavy. Engine and generator have to be large enough to cope with maximum required load.
Straight electric	Requires power connections wherever the vehicle is routed.
Battery-electric	Very heavy and limited distance.
Gyro-motive	Very heavy and limited distance.

The battery-electric road vehicle has been in use for over 50 years for delivery purposes in built-up areas. Economic factors have moved in favour of these vehicles, particularly in the last 20 years, and they are used extensively for the delivery of household commodities and for internal factory transport. It appears that the scope of such vehicles is limited to where the daily mileage does not exceed 40 miles with about eight stops per mile, as indicated by W. D. Sheers.[1] The advantages of this mode of transport are that maintenance expenditure is small and that the electric energy is supplied from the Grid during the night when the load is lightest. The universal adoption of such a vehicle for general transport is limited by the small mileage between charges and the weight of battery required.

The Diesel or petrol-electric method of drive has been mainly limited to very large vehicles and almost exclusively to rail traction. The traction equipment is costly and could not compete with direct mechanical drive for smaller vehicles. The serious disadvantage of this type of drive is that the prime mover and generator must be large enough to deal with the peak load required.

FUEL USED AT MAXIMUM EFFICIENCY

The author believes there is a possible application for transport which utilises more than one form of motive power. The use of two forms of motive power in one vehicle is likely to increase the initial cost but, if designed for economical running and a conserving of a fuel in short supply, then it is worth considering. An example of a combination would be a trolleybus with a gyro. Within one mile of the city centre, where the cost and complication of putting up overhead wires is excessive, the bus would run on its gyro. Outside this radius the bus would pick up overhead wires which would supply the motive power and also recharge the gyro for its next run into the city. Energy would also be stored while waiting at the terminus, thus giving a better load factor.

The method which is discussed in detail in this paper is the combination of petrol-electric and battery-electric. This method has the advantage that it can be applied immediately without waiting for additional power stations to be built or the erection of overhead wires. It also uses petrol with maximum efficiency, a fuel of which there is not likely to be a world shortage in the near future. There are no limitations to the distance the road vehicle will cover and it can be re-routed as easily as the Diesel bus. The prime mover and generator need no longer be large enough to deal with the peak load. In fact, during any stops or slow running, energy would be stored in the battery for future use. When the vehicle was being used for a small mileage (less than say 30 miles) during the day, the engine need never be started up as the battery could be charged up over night from the Grid. Similarly, for economic reasons, the engine could be stopped when, say, 30 miles from home and the last part of the journey carried out from the battery only, which would again be charged overnight. Also the engine could be stopped in heavy traffic and the vehicle run on the battery only. If such a vehicle became popular, the national interests of the country would be served as there would be a considerable saving of motor fuel and a much better load factor for the electrical supply industry.

It is intended to deal in detail in this paper with two types of transport in which there may be considerable economic gains. They are the private motor car and the public transport in a densely populated area.

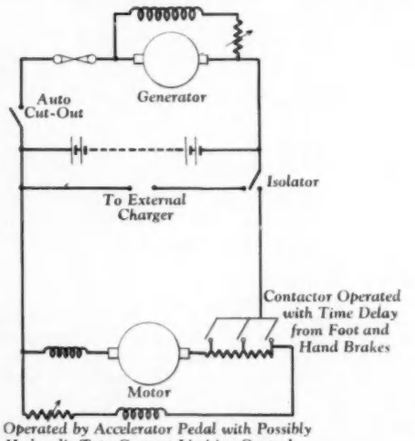
THE PETROL-ELECTRIC CAR

If full advantage is to be taken of the storage capacity of the battery, then regenerative braking should be made possible. A cumulative compound motor, lightly compounded and with shunt field control would, if suitably designed, prevent overload while generating or motoring. The diagram shows connections suitable for a light vehicle. The brake pedal operates the mechanical brakes as well as the starting resistance. The accelerator actuates the shunt field rheostat, which gives as a result electric braking when released. The compound winding would prevent serious overloading if the accelerator pedal was moved too quickly, apart from any mechanical delay which may be introduced. Further protection, except for a red warning light of overload, would not in the author's opinion be necessary. After all, the driver of a petrol engine driven car is not prevented from driving it without cooling water. Some form of meter would be necessary to indicate the state of charge of the battery. Together with the overload warning light, a motor temperature indicator, speedometer, engine speed indicator, fuel indicator and possibly a switched ammeter, these would be all the dashboard instruments required.

A petrol engine could be used but greater efficiency and reliability would be obtained with an air-cooled Diesel engine. Against the Diesel engine is its weight, initial cost and possible shortage of fuel. It would also depend on the quantities required, as Diesel engines are not mass produced to the extent of small petrol engines.

The generator could be of the conventional direct current type with some compounding so that its characteristics could be matched to those of the battery and motor, and thus prevent overloading. Both engine and generator could be mounted at the front of the vehicle for cooling and easy maintenance.

The motor could be of the conventional type used for traction purposes. Use could certainly be made of silicone insulation as this gives a larger overload factor and lighter motor. Traction batteries of either the lead-acid or


Auto Cut-Out
Generator
Isolator
To External Charger
Contactor Operated with Time Delay from Foot and Hand Brakes
Motor
Operated by Accelerator Pedal with Possibly Hydraulic Type Current Limiting Control, to Give 6 to 1 Speed Variation
(4453.)
"ENGINEERING"

Circuit diagram for proposed petrol-electric motor car.

alkaline type could be used. All the other equipment, such as resistances, contactors, protective gear, etc., is already used in battery electric and Diesel-electric vehicles and would be suitable for this type of drive.

COST AND PERFORMANCE

Any calculated performance would, of course, be liable to large variations after prototypes have been built. The purpose of including calculated figures in this paper is purely as an indication of performances. The use of lightweight batteries and silicone insulated machines would greatly improve performance but would put up the initial cost.

It is difficult to estimate to what extent the private motorist is willing to sacrifice high performance for economy of running and safety. The following calculation is designed as a compromise between these needs and is assumed to be equivalent to the larger family car. Except to say there would be a considerable saving in running costs, it would be useless to calculate this figure before a prototype was built. Table II gives the main technical data for a car with reasonable performance.

TABLE II.—*Technical Data for a Petrol-Electric Car*

Road resistance at 40 m.p.h.	32 lb./ton	
Wind resistance at 40 m.p.h.	60 lb.	
Weight—		
Car body and chassis	8	cwt.
Battery	6·5	,,
Motor	2	,,
Petrol-electric generator	8	,,
Control gear	0·5	,,
Total	25	,,

Tractive resistance at 40 m.p.h.—100 lb.
Required horse-power, on the level is 10·7.
Motor—11 h.p., 60V, 160A continuous rating, and 20 h.p., half hour rating.
Generator—10 kW, 60V, 167A, 3,000 r.p.m.
Battery—30 cells, 105Ah, lead-acid.
Petrol engine—15 b.h.p. air-cooled motor-cycle type engine.

Maximum horse-power available with the generator and battery is only limited by the useful discharge rate of the battery and the

heating of the motor. Assuming the maximum available horse-power for a reasonable period to be 20, this would give a performance of 30 m.p.h. up a hill of 1 in 15, 20 m.p.h. up a hill of 1 in 7 and 60 m.p.h. for 20 minutes on the level. A cruising speed of 40 m.p.h. could be maintained for any length of journey. Table III gives the approximate cost of the car.

TABLE III.—*Approximate Cost of a Petrol-Electric Car.*

	£
Body and chassis and accessories (conventional type) ..	350
Battery	130
Petrol-electric generator	200
Control gear, etc.	50
Motor	150
Total	£880

APPLICATION TO PUBLIC TRANSPORT

In estimating the performance of a city omnibus, the author has made free use of the performance data for trolleybuses, already available.[2] The continuously charged vehicle is basically straight electric with self-contained generating equipment and will, therefore, have the same performance. Table IV gives details of

TABLE IV.—*Performance of a Continuously Charged Omnibus.*

Energy consumption, with 6 stops per mile and a scheduled speed of 15 m.p.h. is 2·5 kWh per mile.
Average power required is 37 kW.

Weight—	
Chassis, body, motor, etc.	7 tons 11 cwt.
Battery	1 ,, 15 ,,
Petrol-electric generator	1 ,, 0 ,,
Maximum No. of passengers	5 ,, 0 ,,
Total	15 ,, 6 ,,

Motor—90 h.p., 1 hour rating.
Generator—45 kW, 230 volts, 195 amp., 3,000 r.p.m.
Battery—115 cells, 175 Ah., lead-acid.
Petrol engine—70 b.h.p. car-type engine.

the performance of a double deck vehicle. Again, no attempt has been made to estimate the running cost, but it would be considerably less than that of a conventional Diesel bus.

The maximum available horse-power would be 115 for half an hour. The battery alone, when fully charged, will give 7½ miles running at a scheduled speed of 15 m.p.h. and six stops per mile or approximately 25 miles at an average speed of 20 m.p.h. when running non-stop and unloaded. Table V gives the approximate cost of a double deck vehicle.

TABLE V.—*Approximate Costs of a Continuously Charged Omnibus*

	£
Chassis, body, motor, control gears, etc. (as a trolleybus)	7,000
Battery	735
Petrol-electric generator	800
Total	£8,535

CONCLUSIONS

The performance of the vehicles discussed can be made as good as vehicles of any other existing type. The petrol engine can run at all times at constant speed and maximum efficiency. Energy can be taken from the Grid at night and stored in the battery for use during the day. Driving will be less fatiguing in traffic as regenerative braking is used.

The proposed type of vehicle involves additional equipment to the conventional type but a detailed study will show that the equipment is inherently reliable. All electrical equipment, with the possible exception of the battery, is far more reliable than a Diesel engine, gearbox and clutch. The much smaller engine of the continuously charged vehicle will be cheaper to maintain than a fully rated engine for straight mechanical drive. It is possible, taking everything into consideration, that there would be little difference in maintenance cost between the continuously charged vehicle and the Diesel or petrol driven one.

The figures given in this paper show a distinct disadvantage, as far as initial cost is concerned, for the continuously charged vehicle, but it must be remembered that mechanical propelled vehicles have been mass produced for years. If the electric vehicle was mass produced to the same extent, the figures given in this paper could possibly be halved.

There is no point in having a vehicle which is the cheapest in initial cost and running costs if there is no fuel of the right type to drive it. Natural resources of oil must run out some day and we assume that atomic generated electricity will take over. In the meantime, a transition period will ensue and it would appear to the author that there is a place for the vehicle which can use both types of fuel. As fuel oil becomes scarcer, then this type of vehicle is not scrapped, but bigger batteries could be used or a section of the route could be electrified by means of overhead wires.

It would seem that during this period of transition of our major sources of power, that a vehicle which is adaptable, has much to commend it.

REFERENCES

[1] Sheers, W. D., "Electrical Equipment of Battery Road Vehicles," *Proc. I.E.E.*, vol. 99, part 2, page 457 (1952).
[2] "Trolleybus Electrical Equipment," Metropolitan-Vickers Electrical Company Ltd., SP7579/1.

FRICTION UNDER CONTROL

Friction is one of the natural phenomena which engineers have always to take into account. Its basic laws have been known for centuries, and scientific work of more recent date has enabled a reasonably clear understanding of the complete mechanism of friction to be established. Much thought and no little ingenuity have been devoted to the problem—all important to engineers—of minimising the effect of friction between rotating and sliding surfaces, and some very successful anti-friction devices exist. These, however, are based either on the existence of a film of lubricating fluid, maintained under pressure between two surfaces, or else they achieve the desired result by means of rolling components, and there are numerous instances where neither can be employed. At the top and bottom of the piston stroke in reciprocating engines, for example; in machining operations; in press work, or in extrusion; neither fluid-pressure separation of the surfaces nor rolling friction is practicable. Moreover, there are many cases where the use of fluid-pressure or rolling-friction bearings may be technically possible, but economically unacceptable.

Any practicable method of reducing the effect of friction is obviously of interest and, if it is simple and widely applicable to all types of frictional problems, it is worthy of serious investigation. Such a method has been introduced by Progrega, Limited, South Ward-road, Dundee. Known as the "Progreg" treatment, it provides a strongly-adhering coating to surfaces, which supports heavy loads but has a low shear strength, and so provides very low friction between the surfaces. In addition, the coating is strongly resistant to chemical attack, and so provides extra protection against corrosive wear. The proprietors of the process emphasise that being a surface treatment it does not affect the material treated, though it may well give an apparent increase in strength. In a drawing die, for example, the load capacity will be increased by treatment, but the effect is achieved by reducing the friction and therefore the load, and not by any change in the die steel itself. The overall effect, in all cases, is claimed to be one of reduced friction, with a consequent reduction in wear; either or both of these features may be desired. Both will be welcomed by designers.

In many of the fields in which the process could be used its proprietors have carried out investigations and have, as a result, been able to make some impressive claims. Treatment of all parts subject to wear in an internal combustion engine, for example, prolongs, it is said, their life almost indefinitely, and, by reason of the mechanically strong anti-friction skin, renders the "oiliness" of the oil of much less importance. Less viscous oils can therefore be used as there is no need to fear the squeezing-out effect at dead centre. It is further claimed that higher cylinder-wall temperatures are possible, with a consequent reduction in corrosion, and that, in short, the possibilities are such that a re-design of an engine is necessary to take full advantage of the potentialities of the Progreg process.

Similarly, some remarkable figures are put forward for its use in bearings, machining operations and presswork. Lead bronze bearings, for example, running at 3,000 r.p.m., with a load of 3,000 lb., showed a current consumption of 900 watts in the untreated condition and 28 watts when treated; stalling occurred at 2,000 r.p.m. when untreated, but speeds down to 150 r.p.m. without stalling were possible after treatment. Equally impressive figures are given for the effect of treating tools such as high-speed steel lathe tools (life increased approximately 30 times), twist drills (many in use for 12 months without re-grinding), and stamping dies (9,000 parts off untreated dies, 470,000 parts off treated dies, with no wear). Even grinding wheels are claimed to benefit from the treatment, which penetrates right through the wheel.

The Progreg process is new, and at present it is necessary for components to be sent to the works at Dundee for treatment. Progrega, Limited, intend, however, to establish agencies in this country and overseas, for carrying out the work of processing. It is hardly necessary to say how valuable such a process could be to engineers. Progreg has already aroused interest; its development will pay for watching carefully, for if the revolutionary claims are fully proved in normal commercial applications, its scope is obviously very great indeed.

SECOND TRANSATLANTIC CABLE

Since the first submarine telephone cable was laid across the Atlantic about a year ago, traffic between this country and the American continent has increased by 100 per cent. and that between the United States and Europe by 50 per cent. A second communicating link is therefore to be provided between France and America, which should be ready for service late in 1959. It will comprise about 5,000 nautical miles of cable, over 2,200 miles of which will be manufactured by Submarine Cables Limited, London.

The transatlantic portion of the system will provide 36 telephone circuits and will be equipped with flexible one-way repeaters supplied by Western Electric Company, New Jersey. The twin cables will extend between Clarenville in Newfoundland and Penmarch in Brittany and will be linked by cable and radio relay to the American network. This land line will incorporate rigid type repeaters manufactured by Standard Telephones and Cables Limited, London. At the European end 13 circuits will terminate in Paris and 13 in Frankfurt.

The transatlantic cables will be of substantially the same design as those used on the first link and will consist of inner and outer copper conductors insulated from each other by Polythene. The outer conductor will be held in position by copper binder and protective fabric tapes and will be covered with jute serving and galvanised steel armouring. The overall diameter of the deep-sea portion of the cable will be 1·2 in., but this will be increased to 2·7 in. in the shallow water.

Extreme accuracy in manufacture will be essential, since the attenuation of 2,200 nautical miles of cable is about 1,000 and 3,600 decibels at the lower and higher ends of the transmitted frequency band. The transmission level at any frequency must be maintained to avoid overloading the repeaters at high level or running into interference at low levels. Consequently the variation of attenuation with frequency must be accurately equalised at each repeater. Moreover, prediction of temperature and pressure at sea-bed conditions is required, as the cable characteristics depend appreciably on both these variables.

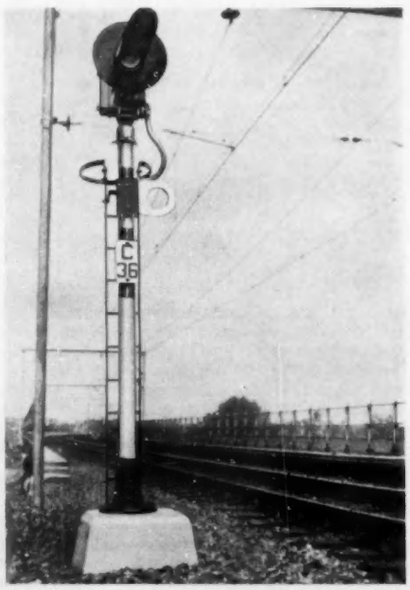
Construction

RAILWAY MODERNISATION—SIGNALLING

Concluded from page 542, *October* 25

IN THE late afternoon of December 10, 1937, an express from Edinburgh to Glasgow overran the home signal at Castlecary station, Dumbartonshire, and collided at about 60 m.p.h. with a Dundee-Glasgow express which was standing in the station. The accident caused the deaths of 35 passengers and injuries to 179 others. It took place an hour after sunset in falling snow. In the subsequent Ministry of Transport report on the accident the Chief Inspecting Officer, Railways, recommended that the subject of automatic train control as a precaution against failure to observe or comply with signals should be considered further without delay.

By the outbreak of war in 1939 a beginning had been made with the installation of a magnetic automatic train control system on the Edinburgh-Glasgow main line, similar to that then in experimental use on most of the London, Tilbury & Southend section of the L.M.S.R. After the war the L.T. & S. installation was brought into full operational service one month before nationalisation, but the new railway organisation of January 1, 1948, made it necessary to select a standard system suitable for application throughout British Railways. Studies were therefore directed to combining the best features of the magnetic system and of the ramp contact system which was already in use on all the principal routes of the Great Western Railway and had seen over 40 years' service.



S.G.E. type "L.C." searchlight signal installed at Chelmsford in connection with the Shenfield-Chelmsford electrification.

While these studies were going forward, the Harrow collision of October 8, 1952, with a death roll of 112, once more brought the subject of automatic train control sharply into the public mind, for the Ministry of Transport inquiry found that the overrunning of signals by the up Perth sleeping-car express had been the primary cause of its colliding with the rear of the local train which was just leaving Harrow and Wealdstone station. It may be recalled that immediately after this collision, a down Manchester and Liverpool express ran into the wreckage of the two trains, although in this case there was no question of signals being overrun and automatic train control could not have prevented this further accident.

Ten days after the Harrow accident the Railway Executive made it known that tests of A.T.C. equipment had been in progress for four years, and that trial apparatus had been installed on the Eastern Region on the down main line from Kings Cross between New Barnet and Huntingdon. A number of main-line locomotives had been equipped for using the system.

When the modernisation plan was published in 1955, an expenditure of £20 million was assumed on the programme for the introduction of automatic train control, or about one-fifth of the total sum estimated for signalling and telecommunications as a whole. Final approval to the form of A.T.C. selected by the British Transport Commission was given by the Minister of Transport in November, 1956. This system is now installed on 210 track-miles, and plans to provide the equipment on all main traffic routes are being pressed ahead. It is the intention to equip some 1,300 miles of route, together with some 10,000 locomotives, by the end of 1962. This programme covers: Kings Cross to Edinburgh via Newcastle; Euston to Glasgow (including Manchester and Liverpool); Edinburgh to Glasgow; Waterloo to Bournemouth and Exeter; and Liverpool Street to Norwich.

The simplicity of colour-light signalling and route indicators is contrasted with semaphore brackets and gantrys in this view showing re-signalling at Bricklayers Arms, Southern Region.

The form of A.T.C. chosen is described as a warning system. It is associated with distant and multiple-aspect signals and gives different audible indications for the "caution" and "clear" aspects. In the event of the signal being at "caution" a brake application is initiated after a brief delay if no action is taken by the driver, but normally he acknowledges a warning by cancelling the action of the apparatus and retaining control of the train himself. This interpretation of automatic train control as a warning device is in accordance with the principle accepted in 1927 by the Automatic Train Control Committee. It will be seen, therefore, that the question has been considered over a long period, but the expense of large-scale installations and the various types of accidents against which A.T.C. gives no protection, but which may have destructive and costly consequences, have retarded decisions in the past.

While not in general involving changes of practice as fundamental as those of the electrification and Diesel programmes, for relay interlocking systems such as are now generally adopted have been used at various places since the 1930s, signalling is an essential background to the operation of faster and more frequent trains by new motive power. The replacement of semaphore signals by colour-lights and the concentration of working in fewer signal boxes have been going on at individual locations and over large areas as part of normal post-war rehabilitation. The re-signalling schemes at York and Cowlairs (Glasgow) are examples of the application of route-relay interlocking to busy traffic centres, that at York being the largest relay interlocking in the world. The colour-light signalling on the Brighton main line of the Southern Region typifies the extension of modern facilities to a complete route. This scheme, carried out in four stages between 1950 and 1955, replaced semaphore signalling between Coulsdon North and the approaches to London Bridge and Victoria, so that colour-lights are now continuous between these termini and Brighton.

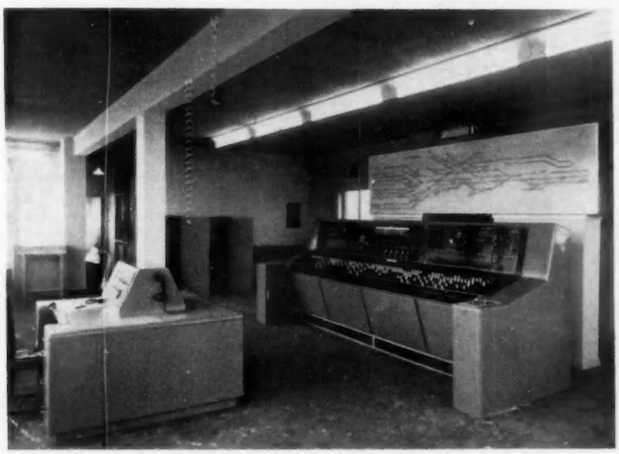
Current schemes do not always involve the complete replacement of mechanical control by electrical methods, but the two may be combined according to the economics of individual cases. On the Western Region, for example, a new 71-lever mechanical frame was put in at West Ealing in 1955 in connection with the changeover from searchlight to multi-aspect colour-light signals between Paddington and Southall. At this box, the frame controls points and certain semaphore signals still in use, while above it is a relay control panel for the operation of colour-light signals and certain power-operated points too far from the box for mechanical control. There is a similar combination of electrical and mechanical methods in the re-signalling of the Glasgow low-level lines completed in 1956, where at two boxes point levers have been retained in conjunction with relay control panels for the colour-lights, operation of the panel key switches being arranged to effect the normal interlocking through electric locks applied to the lever frames instead of by locking bars. At other places mechanical semaphore signalling has been retained but additional track circuits and electrical controls have been provided.

Further orders have been placed for V.H.F. radio equipment to provide communication between marshalling yard staff and the drivers of Diesel shunting locomotives. The enclosed

cab and higher noise level in a Diesel shunter make it likely that this method of passing instructions will gain ground compared with the use of loud-speakers. Other marshalling yard modernisation plans include the installation of railbrakes with electronic controls to measure the speed of wagons running off the hump, and to apply braking pressure accordingly. Considerable study has been directed to methods of recording the passage of wagons through marshalling yards and storing the information.

Improvements in signalling and associated techniques are being accompanied by modernisation of the railways' own communication system, largely by the use of multi-channel, voice-frequency methods to provide maximum capacity on a given circuit. Possibilities in this direction have been increased by the introduction of relatively simple systems enabling the principle to be used over existing line wires in rural areas.

The modernisation plan envisaged the use of centralised train control systems for remote control of signals and points on long single-track routes. This method of working is being developed in several countries overseas, both as full C.T.C., in which the route is continuously track-circuited, and in a modified form under which shorter sections of line, such as passing loops at stations, are controlled from a remote point. It has now been announced that remote control methods will be used for signalling the Sheerness branch of the Southern Region in connection with the re-signalling of the area



(Above) General view of the operating floor of the new St. Pancras signal-box, showing (right) the operating console with its 205 route setting switches and (left) the train recorder's telephone concentrator. Above the console is the illuminated track diagram.

necessitated by the East Kent electrification scheme, while full C.T.C. is to be provided between Perth and Inverness.

Important re-signalling projects announced since publication of the modernisation plan include St. Pancras (completed this month), Newcastle, Glasgow (Central), Huddersfield and Perth. Good progress has been made with the re-signalling of the approaches to the replanned marshalling yard at Temple Mills, Stratford, where considerable economies and improvement in the speed of handling traffic are expected from the concentration into one main and two reservoir yards of work previously carried out in 15 yards.

GENERAL

When the Commission's plans for automatic train control were announced, there was a body of opinion which favoured retaining the system already at work in the Western Region. This system had been shown capable of adaptation to the double-yellow aspect, which was not in force when A.T.C. was first introduced by the Great Western Railway. There is inconvenience, however, in the use of a ramp between the rails, and physical contact with a moving locomotive which must not only allow an electric current to flow but raise and lower a shoe under the locomotive. Although snow or ice might give the effect of a non-energised ramp, which causes the "caution" signal to be sounded, a succession of spurious cautions might lead to a genuine signal being disregarded. Again, if icing causes the locomotive shoe to remain raised after clearing the ramp, the "caution" signal may be sounded continuously, and this introduces the temptation to isolate the apparatus in severe weather conditions, which may be the occasion when its warnings are most needed. Recent development in A.T.C. in other countries has all been in the direction of inductive systems requiring no physical contact between the locomotive and track apparatus, and the magnetic link chosen by the B.T.C. conforms with this trend while allowing development to proceed from a point where operating experience has been gained already in this country. A complication probably unforeseen in 1948, however, is the fact that track inductor magnets will be required on 25 kV/6·6 kV alternating-current lines to initiate automatic changeover of connections between the two voltages in locomotives as well as for signalling, and that there must be no possibility of interaction between the two systems.

The B.T.C. system follows Great Western practice in having separate siren and bell signals for "caution" and "clear" instead of long and short blasts on the siren, but the magnetic link is derived from the Tilbury line installation. A local power supply will be used on the vehicles, as was done on the G.W.R.

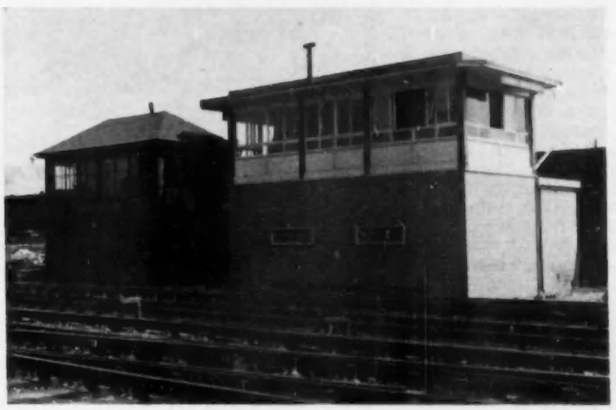
In the original Tilbury line equipments the deflection of an armature in a magnetic receiver when passing over a track magnet acted directly on the brake valve, but later this system, also, was modified so that the armature simply operated contacts in a local power circuit on the locomotive. To ensure immunisation of electric locomotive A.T.C. equipment from alternating traction current effects, a motor-alternator operated from the locomotive supply has been designed to provide an alternating current output at 600 cycles which will be transformed and rectified for operating the A.T.C. relays. Modifications have also been made to the type of indicator originally fitted with the Tilbury line A.T.C. equipment to remind a driver when he has acknowledged a caution signal and assumed control of the braking.

Up to and including the time of the Brighton line colour-light signalling schemes of 1950-1955, the Southern Region was using miniature-lever power frames in signal boxes. Recent contracts for re-signalling on the East Kent lines show that route-relay control panels are now being adopted, which follows practice in recent large installations in other Regions. Considerable variety continues in the methods by which a route is set up. Sometimes two key switches, or a switch and a pushbutton, have to be operated. Alternatively there may be a separate switch for each route, or there may be one switch and a rotary route selector. Controls may be mounted on the track diagram itself or on a console in front of it. The route diagram may show a series of white lights for a route set up, or indications may be confined to showing which way the points are lying. Railway signal engineers appear to differ in their views as to the merits of various practices, and signalling contractors, while their own engineers have their personal views, would not be human if they did not give their customers what they want.

While variety persists, however, there are signs that, outside the signal box, electro-pneumatic operation of points will often be preferred to all-electric working, although the latter method continues to improve in speed of action and at one time claimed easier maintenance. Of recent schemes, York, Cowlairs, Dumfries and St. Pancras have used single individual switches for controlling the signals and points applying to particular routes, but the panel to be supplied for Perth will involve the operation of two switches per route, located on the track diagram in the positions corresponding to its beginning and end. The new signal box recently commissioned at Dumfries station is representative of the combinations of mechanical and electrical working still being employed, a mechanical frame being provided for working points near the box, and key switches for controlling colour-light signals and the more distant points.

The essential in signalling is to present drivers with unambiguous indications by day and night on any routes they cover, and the spread of colour-light schemes is contributing to this purpose. This is well exhibited by the multi-lamp junction indicator which enables one set of colour-light aspects to cover several routes.

(Below) A comparison of the old and new style of signalboxes is shown at Dock Junction—just outside St. Pancras station.



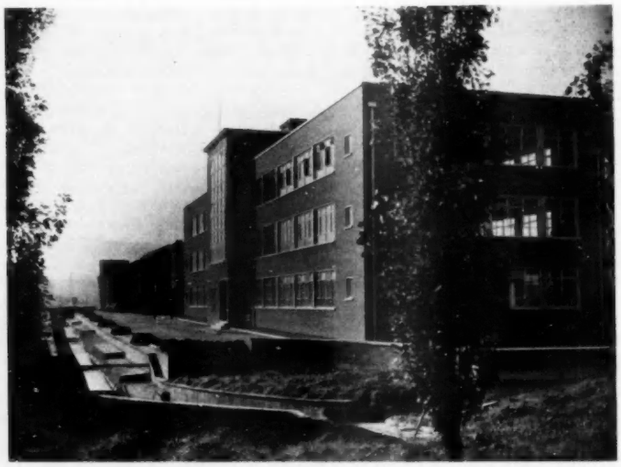
In the four articles that have made up this series on the progress of the railway modernisation plan, little has been said of the civil engineering work involved. Brief mention was made of the changes needed to give adequate clearance for electrification, and provision of service facilities for Diesel stock was indicated. Yet in addition there are the extensive schemes for new (or improved) goods yards, as at Crawley and Temple Mills; for re-siting some lines to give easier working, as at Bletchley and Barking; for additional lines, as at Potters Bar and Hadley Wood; and, possibly most apparent to the traveller, the re-styling and "face-lifting" of many stations. So far, progress on most of these schemes has kept to schedule—indeed some of the construction work is ahead. Future progress, however, will depend not only on the supply of materials and availability of labour, but also on what financial restrictions may be imposed under the recent economy measures.

Continuing **Construction**

LABORATORIES FOR "SYSTEMS" ENGINEERING RESEARCH

As noted in last week's issue, the Research Department of Short Brothers and Harland Limited, Belfast, have recently taken over a spacious new block of laboratories and offices where they will be able to carry out the development of "systems" engineering—servo-mechanisms, computers, and complete control systems—in surroundings that are controversially colourful and lighting that is superb.

Erected by the Northern Ireland Ministry of Commerce to the Research Department's requirements, the new building is a three-storey structure, consisting of a central tower and two wings, designed on the modular principle in order to provide the maximum flexibility of internal layout. The building has a floor area of 23,000 sq. ft. and was completed in the remarkably short time of 16 months. All offices, laboratories and corridors are enclosed by de-mountable partitions and only the permanent features, such as the conference and generator rooms, have solid walls. However, since the partitions are double-skinned and insulated, and reach to the ceiling, the standard of accommodation is more or less that provided by permanent walls.



The new research laboratories of Short Brothers and Harland in Belfast are constructed on the modular principle, for flexibility.

The systems laboratory. Work is in progress here on the simulation of fully-automatic landing techniques.

All offices and laboratories are based on a module of 13 ft., the length of one bay between uprights. The laboratories, in particular, are in multiples of two modules and are therefore 26 ft., 52 ft. or 78 ft. long. Each of the three floors may be divided into two sides by a corridor which is offset from the centre line of the building so that on one side the depth of the rooms is 25 ft. and on the other only 12 ft. Laboratories are for the most part on the wider side, with their offices opposite.

The ground floor accommodates the mechanical laboratory and test room with their heavy equipment, including hydraulic flow and pressure rigs able to work at pressures of 6,000 lb. per sq. in., the workshop, stores, generator room and a number of special-purpose laboratories. The latter include the materials laboratory, equipped with vacuum pumps and evaporation chambers, furnaces, ovens, ball mill, hydraulic press and balances, the climatic test room with temperature and humidity chambers, an instrument laboratory and the standards room. Both the instrument laboratory and the standards room are air-conditioned, and the former contains a vibration-insulated plinth, supported on foundations that are isolated from those of the remainder of the building, for testing precision equipment that might be disturbed by normal building vibration. One wing of the first floor houses the main administrative offices, including a conference room and library. The other wing is occupied entirely by the electronics laboratory which has a floor area of over 3,000 sq. ft. On the second floor are the laboratories and offices of the electro-mechanical section, which houses a wide range of measuring equipment, pen recorders up to eight-channel, coil-winding machines, etc.; the systems laboratory, equipped with a servo-load rig, a special-purpose computer, and servo-operated two-axis and single-axis rocking table for gyro testing; and accommodation for the analytical section, including three Short analogue computers. Access to all floors and to the roof, where open-air experiments can be conducted on radio or radar aerials, is provided by a lift in the central tower.

Particular care has been devoted to the lighting and the distribution of special electrical services. To enable the department to exploit the modular principle, the lighting is arranged so that a uniform intensity of 35 ft.-candles is maintained at desk height throughout the entire building. Fluorescent lights are attached to a trunking system on the ceilings, the spacing of the lamps being co-ordinated with the arrangement of stanchions so that no matter where partitions may be re-erected in any new subdivision, lighting of all enclosed areas will invariably be satisfactory. This is facilitated by the fact that the fluorescent tubes are arranged so that part of their light is thrown on the ceilings; all are provided with louvred diffusers which screen the brilliant surface of the tube and so eliminate glare. If it should become necessary to increase the intensity of the lighting at any point, double-tube fittings can be substituted for those of the normal type.

Since much of the equipment with which the department is concerned requires special electrical supplies, ranging from 24 volts d.c. to a.c. at 400 cycles per second and 2,400 cycles per second, an elaborate system of generation and distribution has been installed. The available supplies comprise 400 cycle 115 volt three-phase, a variable-frequency (1,000 to 2,000 cycles per second), 115 volt supply, 100 to 200 volts d.c., 24 volts d.c. up to 100 amps., 440 volt 50 cycle three-phase and 230 volt 50 cycle single-phase mains supply, and various stabilised d.c. supplies, 200 to 300 volts, these latter being used to expedite the development of electronic equipment requiring stabilised voltage. Supplies are fed from a central generator and battery rooms by groups of screened cables to a local control panel in each laboratory. Supplies, selected by push-button on the local control panel, are then distributed round the laboratory by a "ring main" with junction boxes mounted on the walls at intervals of one bay, or module. Benches are normally grouped in blocks of four, adjacent to a junction box and connected to it by flexible multi-core cables. Each bench is provided with a "bench duct" consisting of a metal channel carrying a large number of flat-pin socket outlets and the various supplies appear on sockets with the appropriate number of contacts and suitably labelled. A number of spare cables run through each laboratory and to the generator room, and can be used either for additional supplies or for linking one bench with any other for control or signalling purposes. The number of circuits available on each bench is about 14, depending on the way the cables are utilised.

All the services in the building, including both the special and domestic electric supplies, heating, water and compressed air pipes are run in a space 5 ft. wide and 2 ft. 6 in. deep formed between the true ceiling and a false ceiling above the corridors. This ceiling duct is provided on all floors, whether partitions are installed or not, and the services pass from one floor to another in a vertical shaft adjacent to the lift well.

★ ★ ★

ECONOMIC CONCRETE FLOORS

Composite floor construction, using rolled steel joists with a concrete slab, have been accepted design practice for many years. Such a system is, however, uneconomical, because the top part of the joist is under-stressed. To overcome this waste of steel Mackey Bowley and Company, Limited, 21 Caledonian-road, London, N.1, have developed a composite beam in which the understressed top half of the beam is replaced by a loose coil of $\frac{3}{8}$ in. mild steel rod. Standard R.S.J's are slit to make two T-sections and the coil is tack welded along the cut edge of the joist web, the coil pitch being varied to resist the longitudinal shear. Full-scale tests have shown the beams to be structurally sound and to effect a saving of nearly 50 per cent. in the steel; the advantage of easy construction given by the conventional use of joists is retained.

BRITISH BROAD FLANGE BEAMS IN 1958

Dorman Long's Universal Mill Coming into Production

ROLLED sections with broad flanges and of open-hearth structural steel to the British Specification will become available during 1958. With their higher section modulus in terms of weight per foot run and inch of depth than the corresponding British Standard I-beams, they will have a cross-section which for many tasks is structurally more efficient; the range of sections to be rolled will also be much longer, the largest of the new beams being a 36 × 16½ × 260 lb. per foot section, as compared to the conventional 24 × 7½ × 95 lb. beam. The combination of heavier sections and of a larger section modulus throughout the range will inevitably cut overall structural steel costs by eliminating a great deal of fabrication; the saving in weight on plain sections is likely to be between 5 and 10 per cent. The new sections are to be rolled at Dorman Long's universal mill now being completed at Lackenby on Teeside.

As will be well known, similar broad-flange sections have been available from continental and United States sources for a good many years; some over-rolled broad-flange beams have also been available from a British source—and greatly appreciated they have been too. Those from the Continent, however, have been rolled from a lower-strength steel than has been acceptable here and those from America have been expensive. The new sections should make British fabricated steelwork the cheapest throughout much of the industrial world.

Details of the new sections, and of the plant which has been laid down to roll them, were given in a paper read before the Institution of Structural Engineers on October 31 last.* The paper was entitled "Universal Beams and their Applications" and it was presented by Mr. S. Barlow, a special director and general manager of the structural activities of Dorman Long (Bridge and Engineering) Limited, and Mr. G. Foster, superintendent of rolling mill development for the group.

Two forms of section will be produced: (*a*) beam sections having a small flange taper of 2 deg. 52 min. (as compared to 8 deg. for British Standard sections); (*b*) column sections with nominally parallel flanges. The toe of both type of section will be square.

At present the intention is to roll 44 different sizes of beam and 27 column sections. The beams cover a range of 15 serial sizes and the columns 6 sizes, one of which—the 12 by 12—has as many as seven different weights per foot run. In addition, it is proposed to roll 20 sizes of angles, channels and piling in matching sections. An appendix attached to the paper tabulates the dimensions and section characteristics (second moments of area, elastic and plastic moduli) for all the proposed beam and column sections. Part of that appendix is reproduced in the accompanying table to indicate the range of the new universal sections. It must be emphasised that this list is not complete, neither is it intended to be a preferred list of sections. It is merely to show the range of sections available.

* The paper is published in full in the November, 1957, issue of *The Structural Engineer*.

An Abbreviated List of Universal Beam and Column Sections, showing Principal Dimensions and Section Data.

Serial size, in.	Weight per ft., lb.	Area of section, in.²	Moments of inertia		Radius of gyration		Elastic modulus		Plastic modulus		Nominal size, in.
			About *x*—*x* in.⁴	About *y*—*y* in.⁴	About *x*—*x* in.	About *y*—*y* in.	About *x*—*x* in.³	About *y*—*y* in.³	About *x*—*x* in.³	About *y*—*y* in.³	
36 × 16½	260	76·56	17234	1021	15·00	3·65	951·1	123·3	1076	195·6	36¼ × 16⅝
36 × 12	170	49·98	10470	300·6	14·47	2·45	579·1	50·0	667·0	80·7	36⅜ × 12
30 × 10½	132	38·83	5753·1	185·0	12·17	2·18	379·7	35·1	436·7	56·4	30⅛ × 10⅛
24 × 12	160	47·05	4979·2	359·7	10·29	2·77	399·6	58·7	454·4	92·9	24⅛ × 12¼
24 × 9	94	27·63	2683·0	102·2	9·85	1·92	220·9	22·6	252·7	36·1	24⅛ × 9⅛
21 × 8¼	82	24·12	1827·8	77·1	8·70	1·79	170·5	18·5	195·2	29·5	21⅛ × 8⅛
16 × 7	50	14·70	655·4	34·8	6·68	1·54	80·7	9·84	91·6	15·7	16¼ × 7⅛
12 × 6½	36	10·59	280·8	23·7	5·15	1·50	45·9	7·23	51·5	11·4	12¼ × 6⅛
10 × 5¾	29	8·53	157·3	15·2	4·29	1·34	30·8	5·25	34·6	8·27	10¼ × 5⅛
8 × 5¼	20	5·88	69·2	8·50	3·43	1·20	17·0	3·23	19·1	5·11	8⅛ × 5¼
14 × 16	426	125·25	6610·3	2359·5	7·26	4·34	707·4	282·7	869·4	434·1	18⅛ × 16⅛
Column core	320	94·12	4141·7	1635·1	6·63	4·17	492·8	195·7	591·9	303·8	16⅛ × 16⅛
14 × 14½	87	25·56	966·9	349·7	6·15	3·70	138·1	48·2	151·4	773·0	14 × 14½
12 × 12	190	55·86	1892·6	589·7	5·82	3·25	263·2	93·1	311·3	142·6	14⅛ × 12⅛
	65	19·11	533·4	174·6	5·28	3·02	88·0	29·1	97·0	44·1	12⅛ × 12
10 × 10	60	17·66	343·7	116·5	4·41	2·57	67·1	23·1	75·0	35·1	10¼ × 10⅛
8 × 8	48	14·11	183·7	60·9	3·61	2·08	43·2	15·0	49·0	22·8	8½ × 8⅛
6 × 6	25	7·35	53·3	17·0	2·69	1·52	16·7	5·63	18·9	8·55	6⅛ × 6⅛

This list is not complete: neither is it a list of preferred sections.

AN UNDERPASS FOR LONDON?

Construction Difficulties with Severe Traffic Congestion

The construction of an underpass has been proposed to relieve traffic congestion at one o London's busiest road junctions—that at Hyde Park Corner, which is frequently used by 80,000 vehicles in the 12 hours from 8 a.m. every week day. The project is part of a major road scheme for the area, the cost of which is put at £4,500,000. The underpass itself would cost about one-third of this figure.

Both Paris and Brussels have or are constructing underpasses to speed traffic at busy crossroads. The principle is to take a particular traffic route (for example, vehicles which are proceeding directly across the junction) into a shallow tunnel which passes under the crossing and so leave more room at the surface for other traffic to manoeuvre.

For an underpass to be considered the thoroughfare must be wide enough at the points where the approach ramps lead in and out of the tunnel to accommodate both the tunnel approaches and the traffic lanes required by the vehicles not taking the underpass route. At the junction itself, however, such a great width is not so necessary. It is also necessary that the sub-strata shall be sufficiently clear of obstructions: water mains, sewers and other services may have to be diverted or other special provisions may have to be made.

In London and in Paris, many traffic junctions could not be improved by underpasses because of the shallow depth of the underground railway system at the particular point. At Hyde Park Corner, the London Transport Executive's Piccadilly Line lies directly below what appears to be the proposed course of the underpass, which is to link Knightsbridge with Piccadilly. The tube railway at this point, however, is at such a depth as will not interfere with the construction of the underpass, though some added protection of the railway tunnels may be necessary.

At a Brussels road junction where an underpass is being constructed, some 30,000 vehicles are handled during a 16-hour day, a figure much below that at Hyde Park Corner. There, however, it has proved practicable to build the tunnel as a box structure, putting the walls down in narrow trenches, constructing the soffit together with a new road surface in sections, and then taking out the dumpling and laying the invert. One such underpass has taken about 18 months to complete. This method of construction—or any other that can be envisaged—necessarily restricts the traffic lanes available during the whole period of construction and until the underpass can be opened. At Hyde Park Corner, this particular difficulty would seem to be eased by two factors. Firstly, all the other parts of the scheme could be completed before the tunnel was tackled. This involves developing the roadway within Hyde Park to take only northbound traffic, making Park-lane available for southbound traffic only, and taking over land so that the traffic-circulation space would be much increased. With this work complete the traffic congestion in the vicinity would be much relieved. Secondly, part of the circulating area will be occupied by a traffic roundabout under which much of the underpass will run. A considerable length of the tunnel could therefore be built and more or less completed below the island without interfering with traffic movements at all. This work could be done simultaneously or even completed before any major start was made on the approaches, the construction of which would inevitably interfere with traffic movements.

Altogether the proposed tunnel is to be some 330 yards long and will be of such a height and width as to take one lane of all classes of traffic in each direction, though it is not proposed that London Transport's buses should use it. The curves will be easy, and modern ventilation and lighting equipment will be installed. The project has been put forward by the L.C.C.'s Town Planning Committee, and now awaits the approval of the Council and Government sanction.

Production

FIBREGLASS BOATS

Fig. 1 (left) Laying up a glass-reinforced polyester resin boat hull inside the mould—itself a reinforced polyester moulding.

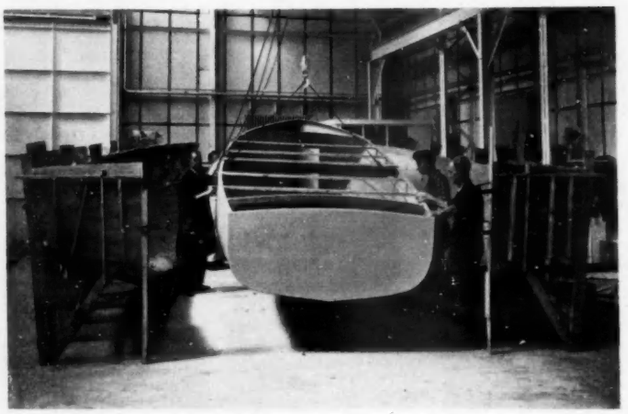


Fig. 2 (right) The moulded boat released from the bonded Fibreglass mould, which is made in two parts for easy release.

SYNTHETIC resin reinforced with glass fibres as a constructional material for the hulls of small and medium-size boats—the type of boats that are produced in fairly large numbers—is becoming increasingly popular on account of its immunity from attack by marine borers and other forms of underwater life; the fact that it requires no painting and therefore very little maintenance; its high strength and light weight, if carefully designed; its easy repairability; and the rapidity with which standard hull forms can be produced. The latest firm to enter the field of Fibreglass boat construction is John I. Thornycroft and Company, Limited, Platts Eyot, Hampton-on-Thames. For the past three years they have been carrying out extensive development work on glass-reinforced polyester resin structures, and now they are in commercial production with four types of boat—the Gyrinus class 16 ft. general-purpose round-bilge dinghy, suitable for Diesel or petrol machinery; the Dragonfly class 24 ft. round-bilge work boat for mooring and dock duties; the Polywog class 28 ft. 6 in. multi-purpose hull which is suitable as an open launch, a passenger-carrying launch with canopy, a towing launch or a police launch, all designed to take a wide variety of Thornycroft Diesel engines up to 90 h.p. and with speeds up to 12 knots; and the Danielle class 28 ft. 6 in. cabin cruiser, with a choice of interior layout and a single Thornycroft Diesel or twin petrol engines as desired. With a 30 b.h.p. Thornycroft RTR.4 marine Diesel engine, Danielle has a speed of 8 knots and a range of 150 nautical miles. Danielle will be seen in public for the first time at the National Boat Show in the New Year.

Although at present Thornycroft are only handling Fibreglass boats up to 30 ft. long, their Fibreglass shop has a capacity for boats up to 50/60 ft. They have found that for satisfactory lay up of the glass-reinforced hull, close control of shop temperature and humidity is essential. Their practice is firstly to build a complete hull in traditional wooden construction, and to use this as a master mould on the outside of which the secondary mould, of polyester resin reinforced with 1½ oz. glass mat, is built up in two longitudinal halves, which are bolted together to form the final mould for the actual Fibreglass hulls. These are laid up inside the secondary mould which can, if necessary, be dismantled to withdraw the hull when curing is complete.

In laying up a hull, firstly furniture polish is applied to the inside of the secondary mould, as a separating medium. Then follows the most critical operation—the application of the first resin coating on which the success of the whole moulding is largely dependent. This coat is allowed to set almost, but not quite, hard, and then fine glass "surfacing" mats are placed in position over the inside surface of the mould, and are impregnated with polyester resin. The latter—comprising pure resin plus the promoter and catalyst necessary for curing, together with colouring matter and, in the case of vertical surfaces, "fillers" to prevent the resin from running—is applied with a brush, and rollers are used to eliminate entrapped air. Further layers of glass mat, of heavier texture (usually 1½ oz. per sq. ft.) than the surfacing mats which provide the smooth outer face of the moulding, are then laid up and impregnated until a sufficient thickness has been built up. Stiffening members of hardwood or light alloy tube or section may be bonded in during the moulding process to give additional stiffness where this is necessary. The moulding is cured at room temperature for several days. For the sake, mainly, of appearance, Thornycroft prefer to use wood for decks, superstructure, furniture and bulkheads—although they may sometimes adopt "sandwich" type bulkheads with Dufaylite honeycomb core between glass-reinforced resin skins. No woodworking is carried out in the moulding shop.

* * *

CLEANING HANDS IN WORKS AND OFFICE

A new range of cleansers, known as Kerocleanse 21, 22 and 23, has recently been introduced by Scientific Pharmacals Limited, complementary to their well-established Kerodex range of industrial barrier creams. Kerocleanse creams, which are non-inflammable non-irritant solvents in the form of emulsions of oil in water, are used at the bench or the office table. They do not spread contaminants, as do certain neat solvents, and they are compatible with soap and water.

In particular, the increasing use of synthetic resins and adhesives in industry calls for special care in the prevention of dermatitis. Frequent daily exposures, at low concentrations, to the hardeners used in these resins will produce, after a time, a sensitisation type of dermatitis which becomes more severe with each further exposure. This sensitivity can become permanent, and will then cause a reaction to minimal exposures years afterwards. The most important step in protection against the resin formulations is personal hygiene. When skin is contaminated it must be thoroughly and frequently cleaned. To leave deposits of these irritants on the skin hour after hour is inviting trouble, but cleaning off partially cured resin is not easy. Soap and hot water is not effective. Solvents of the acetone type can emulsify partially cured resins but the frequent use of such solvents destroys the natural defensive mechanisms of the skin and allows easier penetration of the irritant.

To solve the problem, Kerocleanse 22 has been developed; it is a resin-removing cream effective against epoxide, furane, urea-formaldehyde and resorcinol-formaldehyde resins, and a range of rubber-based adhesives and resin-bonded inks. It is also effective in removing crude fuel oils and bituminous compounds.

Another cream, Kerocleanse 21, has been developed for use in the drawing office and general office, for removing carbon stains, duplicating inks, drawing and printing inks, especially those in a solvent base, which are usually beyond the powers of soap and water.

The third member of the Kerocleanse range, 23, is a special-purpose cream developed for the Admiralty, and still under evaluation, for removing fuel oil in cold salt water. It is now being supplied for the life-saving equipment for shipwrecked survivors who may be contaminated with heavy fuel oil.

Particulars of these products are available from Mr. A. S. Hughes, Scientific Pharmacals Limited, 1 Eden-street, London, N.W.1.

MANUFACTURE OF SUPERHEATERS

The Superheater Company, Limited, whose head office is at 53 Haymarket, London, S.W.1, were founded in 1910 and built their first works at Trafford Park, Manchester, in 1914. These consisted of two shops on a site of one acre. With the recent completion of two new bays, the present area is 16 acres, of which 10 are covered.

An open day was held recently for visitors to see both the new bays and the re-arrangement that has been carried out in the older part of the works. Most of the locomotive side of superheater production has been moved to the new buildings, allowing more space for the stationary plant equipment, the demand for which continues to increase. The new bays are 420 ft. long and 80 ft. wide; the architects were Harry S. Fairhurst and Son, of Manchester, and the main contractors A. Monk and Company, Limited, Padgate, Warrington. Products of the Indestructible Paint Company, Limited, 6, Chesterfield-gardens, Curzon-street, London, W.1, were exclusively used for the wall surfaces of both the works and the office and canteen block.

The process of making the superheater tubes for locomotive boilers has changed little over many years. Ball ends are upset on the tube ends by hot forging, and later machined by hand tools to give good joint surfaces. To form reverse bends of very small radius, two tubes are laid

side by side in a horizontal forging machine, the ram being a pair of cones. One cone enters each tube and so forges the adjacent faces together; in subsequent operations the excess material is cut off and the opening sealed, again by hot forging. In stationary plant, when space permits a much larger radius at the reverse bend, continuous lengths of tube are used and are bent to shape in a machine. To obtain continuous tube of the necessary length (which may be very considerable) shorter lengths are electrically butt-welded in machines. Complete assemblies can be stress-relieved in a heat-treatment furnace which has a capacity of 6 ft. by 6 ft. by 40 ft. and can operate at temperatures which are as high as 750 deg. C.

Twenty years ago, steam conditions of 650 lb. per sq. in. and 800 deg. F. were considered high, and an evaporator of 250,000 lb. per hour very large. Now power designs are for 2,400 lb. per sq. in. at 1,055 deg. F. from units with capacities of 3,900,000 lb. per hour. Such conditions call for high alloy and stainless steels which have necessitated acquiring new techniques.

The company's products include all forms of heat-exchanger as well as actual superheaters. Dryers and steam purity test apparatus are also made. At present about 52 per cent. of the production is for export, about 40 countries being on the firm's list.

TIME SAVING IN STATISTICAL FATIGUE EXPERIMENTS

By N. T. Bloomer, Ph.D.

It is well known that when nominally identical components are subjected to nominally identical stress cycles in a fatigue testing machine, different components survive different numbers of cycles before failing. It has been suggested by Muller-Stock[1] and others that the logarithms of these life values are distributed normally, and adopting this supposition the probability of failure of a component before any given life value is achieved may be calculated, provided that the mean value and standard deviation of this normal distribution are known.

If n components are tested and their lives to failure $N_1, N_2 \ldots N_r$ have logarithms $x_1, x_2 \ldots x_n$, then the mean is denoted by $\bar{x} = \frac{\sum_{i=1}^{n} x_i}{n}$, and the standard deviation, s, is found from

$$s^2 = \frac{\sum_{i=1}^{n} (x_i - x)^2}{n-1}.$$

To obtain these two parameters ($\bar{x}$, s) with some accuracy it is necessary that n should be fairly large and this involves considerable testing time (especially at stresses near the endurance limit). Furthermore it sometimes happens that certain specimens which seem to have a very long life are not run after a given large number of cycles, and the inclusion of these observations in the above equations for obtaining the parameters is impossible. Each of these difficulties may be overcome by removing specimens from test after a given arbitrary life if they have not broken, recording the lives achieved by those that did break, and then using the standard methods for deducing normal distribution parameters when the data is incomplete. The parameters deduced are the " most likely " parameters and they are estimated by the " method of maximum likelihood."[2]

Two situations are likely to arise. In the " truncated " set of results, only results above (or below) a certain value are recorded and the number of observations that did not reach (or exceeded) this value is not known. The second case, which is called a " censored " set of results, consists of the results above (or below) a certain value and the number of observations that have not been specifically recorded: hence more information is available about censored results than about truncated results, and though truncation estimates of the parameters may be obtained in the latter case, they may not be as accurate as the censored estimates.

In the following paragraphs, the methods to be used in each case will be given, together with examples using the 20 smallest results of the 100 listed in Table I (taken from Ref. 3). The parameters obtained for the 20 values are very similar to those obtained for the complete set of 100.

TRUNCATION

Suppose $x_1, x_2, \ldots x_n$ denote n observed values with the point of truncation as the origin and $x_i > 0$.

First compute

$$y = \frac{n \sum_{i=1}^{n} x_i^2}{2\left(\sum_{i=1}^{n} x_i\right)^2}.$$

Then from Table IX of Ref. 4 an estimate of the standardised point of truncation is found as $z = f(y)$.

Still using Table IX to find $g(z)$, further computation gives

$$s = \frac{1}{n} \sum_{i=1}^{n} x_i \, g(z), \text{ and } \bar{x} = -zs.$$

These values, s and $\bar{x}$ are then the most likely parameters.

ONE-SIDED CENSORED NORMAL DISTRIBUTION

Let n observations from a normally distributed population be divided into 2 groups, " a " observations being $\leqslant 0$ (the point of truncation), and $n-a$ observations > 0. It is assumed that the " a " observations are not further specified, while the individual values of the $n-a$ observations, $x_1, x_i, \ldots x_{n-a}$ are known.

In this case compute

$$y = \frac{(n-a) \sum_{i=1}^{n-a} x_i^2}{2\left(\sum_{i=1}^{n-a} x_i\right)^2}, \text{ choose } h = \frac{a}{n},$$

and from Table III of Ref. 2 obtain an estimate of the standardised point of truncation as $z = f(h, y)$.

Next an estimate of the parameter s is computed from

$$s = \frac{\sum_{i=1}^{n-a} x_i}{n-a} g(h, z)$$

with the aid of Table X, Ref. 4, and an estimate of $\bar{x}$ from $\bar{x} = -zs$. Now there are certain difficulties in the immediate application of these formulae. First, the value of h must be $\leqslant 0{\cdot}8$ for use of Table III. Secondly, for fatigue testing it is usual to neglect not the small end of the distribution but the large end, while the formulae given above are for lower truncation only. This difficulty may be overcome by considering the distribution as " reversed," and by an alteration of sign and origin value, truncations up to 80 per cent. can be dealt with.

METHOD IN PRACTICE

Consider the values listed in Table I. If these are supposed normally distributed, the computation of the mean and standard deviation using all the results yields the values $\bar{x} = 5{\cdot}7129$, and $s = 0{\cdot}098$.

Suppose now that only the first 20 values were obtained and that no specimen was run after a life given by $\log_{10} N = 5{\cdot}63$. Then Table II could have been compiled.

TABLE I.—*Values of $x = \log_{10} N$ in Order of Magnitude*

5·48	5·501	5·505	5·539	5·541	5·542	5·567	5·567	5·574
5·576	5·582	5·595	5·604	5·611	5·612	5·613	5·613	5·624
5·626	5·629	5·632	5·634	5·635	5·641	5·641	5·647	5·662
5·663	5·665	5·668	5·668	5·670	5·674	5·675	5·676	5·679
5·681	5·681	5·686	5·692	5·692	5·693	5·693	4·693	5·696
5·697	5·699	5·700	5·702	5·705	5·705	5·705	5·707	5·710
5·716	5·718	5·719	5·720	5·736	5·737	5·740	5·740	5·741
5·748	5·749	5·751	5·751	5·752	5·752	5·758	5·761	5·769
5·769	5·773	5·774	5·774	5·775	5·776	5·782	5·786	5·787
5·787	5·793	5·798	5·799	5·800	5·802	5·805	5·811	5·828
5·844	5·862	5·892	5·896	5·901	5·917	5·922	5·924	5·942
5·997								

TABLE II.—*Parameters Calculated from First 20 Values of Table I*

x	$\lambda = 5{\cdot}63 - x$	$\lambda^2 \times 10^6$
5·48	0·150	22,500
5·501	0·129	16,641
5·505	0·125	15,625
5·539	0·091	8,281
5·541	0·089	7,921
5·542	0·088	7,744
5·567	0·063	3,969
5·567	0·063	3,969
5·574	0·056	3,136
5·576	0·054	2,916
5·582	0·048	2,304
5·595	0·035	1,225
5·604	0·026	676
5·611	0·019	361
5·612	0·018	324
5·613	0·017	289
5·613	0·017	289
5·624	0·006	36
5·626	0·004	16
5·629	0·001	1
	$\Sigma\,\lambda = 1{\cdot}099$	$\Sigma\,\lambda^2 = 98{,}223 \times 10^{-6}$

First suppose that the values obtained were from a truncated test, i.e. it was not known how many exceeded a life given by $\log_{10} N = 5{\cdot}63$.

Then

$$y = \frac{20 \times 98223 \times 10^{-6}}{2 \times 1{\cdot}099 \times 1{\cdot}099} = 0{\cdot}8132$$

so from Table IX (Hald) z is found to be $0{\cdot}328$, $g(z) = 1{\cdot}45$, giving

$$s = \frac{1{\cdot}099 \times 1{\cdot}45}{20} \simeq 0{\cdot}080$$

and

$$\bar{\lambda} = -zs = 0{\cdot}080 \times 0{\cdot}328 = -0{\cdot}0262$$

so

$$\bar{x} = 5{\cdot}63 - \bar{\lambda} = 5{\cdot}6562$$

These values of $\bar{x}$ and s are not very close to the values obtained from the whole sample.

Consider now the censored case, where the additional information is given that 80 specimens survived a life given by $\log_{10} N = 5{\cdot}63$, i.e., $a = 80$, $n = 100$, and $h = 0{\cdot}80$

Then

$$y = \frac{20 \times 98223 \times 10^{-6}}{2 \times 1{\cdot}099 \times 1{\cdot}099} = 0{\cdot}8132 \text{ as before}$$

and, from Table III of Ref. 2, z is found to be $f(0{\cdot}8, 0{\cdot}8132) \simeq 0{\cdot}838$.

Use of Table X of Ref. 4 yields

$$s \simeq \frac{1{\cdot}099}{20} \times g(h, z)$$

$$= \frac{1{\cdot}099}{20} \times \frac{20}{80 \times 0{\cdot}3518 - 20 \times 0{\cdot}838}$$

$$= 0{\cdot}0965$$

and $\bar{\lambda} = -zs$, is found to be $-0{\cdot}0809$.

Finally $\bar{x} = 5{\cdot}63 - \bar{\lambda}$ is deduced to be $5{\cdot}7109$. A comparison of the parameters obtained from the complete set of 100 results with the parameters obtained by both the truncated and censored estimates are given in Table III.

TABLE III.—*Comparison of Truncation and Censorship Techniques*

	$\bar{x}$	s
100 results	5·7129	0·098
80 per cent. truncation	5·6562	0·080
80 per cent. censorship	5·7109	0·0965

It is seen that the censorship method gives parameters very close to those obtained from the complete set of results: much closer in fact than the truncation method. This is, of course, to be expected, and it is fortunate that normal fatigue testing procedure gives the proportion of specimens surviving the (arbitrarily) assumed point of truncation. Hence the censorship method may be used. The saving in time may be considerable since a " long running " specimen can occupy a valuable machine for a very long period without giving very much information. Whilst the example given here has used 80 per cent. truncation, this is not recommended, anyway certainly not for smaller samples. A truncation of $\simeq 50$ per cent. however could be of great value to an experimenter.

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[2] Hald, A., " Maximum likelihood estimation of the parameters of a normal distribution which is truncated at a known point." *Skandinavisk Actuarietidskrift*, pages 119-134 (1949).

[3] Pope, J. A., Foster, B. K. and Bloomer, N. T., " Limited life design: a survey of the problem." ENGINEERING, vol. 184, page 236 (1957).

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Atomic Review

Ground Run

THE prospect of using nuclear power for propelling aircraft has been recognised widely; the feasibility of such a project has not. Opinions differ. Speaking at a press conference last February, Mr. C. E. Wilson, Defence Secretary of the United States, stated that it would take a "miracle or two" before the United States will be able to build an atomic-powered airplane. An opposite view is taken by Mr. R. E. Gross, chairman of the Lockheed Aircraft Corporation, who believes that his company could assembly a nuclear powered aircraft in three years, provided the United States Government gave the go-ahead signal and the company could count on the supply of a propulsion system when ready for it. Recently it was disclosed that Lockheed have been working on the use of nuclear power to propel missiles.

Both the United States and the U.S.S.R. have been carrying out experimental flights with an airborne reactor, in order to test control and screening problems and to test the effect of the radiation on aircraft materials during flight. In Great Britain the Ministry of Supply is undertaking preliminary research into the application of atomic power to aero engines and it has been rumoured that one of the Saunders-Roe Princess flying boats may be used as a test bed.

Some details of the United States aircraft reactor experiment (ARE) were given by Mr. A. M. Weinberg in a paper "The Nature of Reactor Technology and Reactor Development" presented at the Inter-American Symposium on the Peaceful Application of Nuclear Energy, held at the Brookhaven National Laboratory. Some of his remarks on ARE are summarised below.

Chemical or Mechanical Rationalisation

Mr. Weinberg—he is director of the Oak Ridge National Laboratory—discusses the question whether a reactor is basically a chemical plant or a mechanical one, pointing out that his inquiry is the necessary preliminary before the answer to the further question "Is the essential rationalisation of reactors to be a chemical rationalisation or is it to be a mechanical rationalisation?" can be reached. Two examples are considered in detail—the homogeneous reactor test (HRT) and the army package power reactor (APPR-1).

Then, as a further example of the chemical approach to reactor design, he describes another liquid-fuel development that has been pursued (simultaneously with that of HRT) at the Oak Ridge National Laboratory, namely, ARE.

Aqueous Homogeneous Disadvantages

Aqueous homogeneous reactors such as HRT suffer from two serious disadvantages. First, the pressure required for even moderately high temperatures is very high. So the thermal efficiency obtained with such a reactor is necessarily low. Second, there is no practical water-soluble thorium compound (except the nitrate, which absorbs too many neutrons). This means that aqueous homogeneous thorium breeders involve a slurry blanket. A lesser disadvantage is the decomposition of the water by radiation. A liquid fuel that allows high temperatures at low pressure is required: it should dissolve thorium and not be decomposed by radiation.

Fluoride Fuels

Such a fuel is available; namely, molten mixtures of the fluorides of uranium and thorium carried in the fluorides of other metals. NaF-BeF-UF_4 is an example of this type of fuel. ThF_4-Li^7F-BeF_2 is a suitable breeder blanket material.

But the fluorides have their own disadvantages. First, they melt at rather high temperatures—about 500 deg. C. Second, they are not as good moderators as heavy water—as a consequence the concentration of U235 in a fluoride system must exceed that in a heavy-water one. Also, when the hold-up in the external system is counted, the material efficiency of the system tends to be low. A further disadvantage is that the breeding ratios achievable in fluoride systems are less favourable than in D_2O systems, because the fluoride salts used as carriers absorb neutrons.

As far as corrosion is concerned, the fluoride systems are entirely different from the aqueous systems, since no protective film is involved. The question whether corrosion in fluoride systems can be held down sufficiently to allow a molten-fluoride reactor to operate for many years is one on which Oak Ridge is now working.

The incentive for achieving a successful high-temperature reactor that burns U235 in liquid form can be seen from the following economic consideration put forward by Mr. Weinberg. If U235 costs 17 dols. per gram, and if it can be burned without refabrication (i.e., in liquid form) in a very high-temperature reactor with a thermal efficiency of 35 per cent., the fuel cost, just as in a straight burner, amounts to about 2 to 3 mills per kWh. This is competitive with the best conventional fuel costs. Thus, the possibility of large-scale conversion of cheap Kentucky and Tennessee coal into cheap electricity at places far from Kentucky and Tennessee by first converting the coal to U235 in a diffusion plant depends on being able to burn the U235 in liquid form in a device which produces the power at very high temperatures. In addition, the high temperatures achievable with the molten fluorides make them of interest for aircraft application.

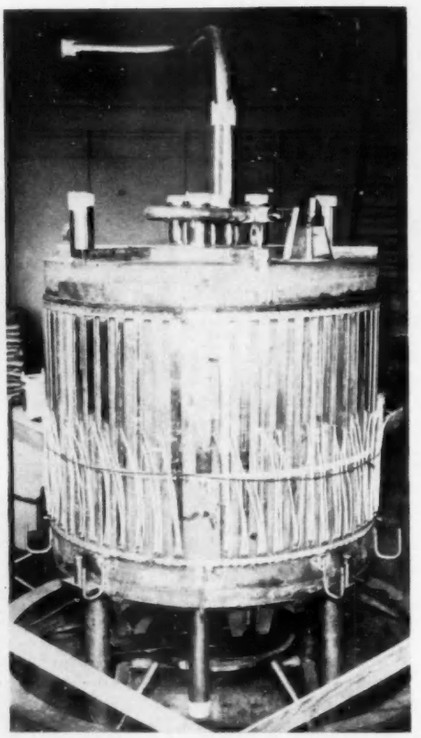


Fig. 1 The external casing of the reactor vessel for the Aircraft Reactor Experiment (ARE) is primarily a thermal shield. The reactor ran at a peak power of 2·5 MW.

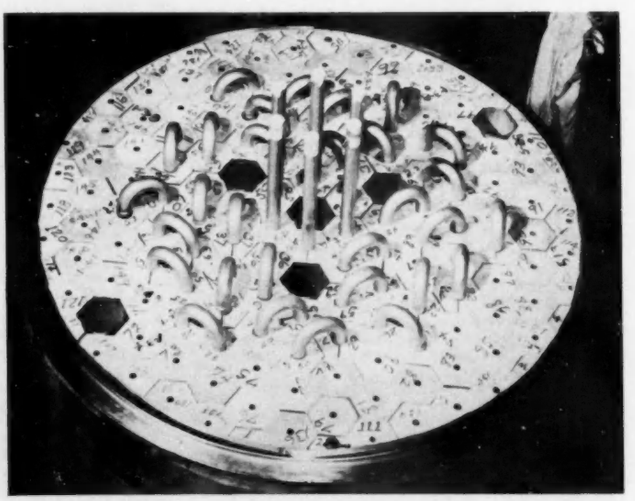


Fig. 2 The top view of the ARE core shows the looped tops of the tubes that carry the molten fluoride fuel. Beryllia provides both moderator and reflector.

Aircraft Reactor Experiment

With such considerations in mind, the Oak Ridge National Laboratory decided that it was worth-while to construct and operate a very-high-temperature molten-fluoride U235 burner reactor—even before the difficult problems of long-term metal attack by the fluorides had been solved. Following this decision, the Laboratory in 1954 performed what was called the Aircraft Reactor Experiment (ARE) with molten-fluoride fuel.

The ARE was a circulating-fuel extremely high-temperature reactor in which the fuel was a mixture of molten fluoride salts containing UF_4. The reactor vessel is shown in Fig. 1, the core in Fig. 2. As the moderating power of the constituents of the fuel was not sufficient to sustain a chain reaction with the uranium concentrations used, it was necessary to provide a separate moderator; beryllium oxide was chosen. Fig. 3 shows a cross-section of this reactor. The fuel flowed in serpentine nickel-alloy tubes through the reactor, where the system became critical. The liquid was pumped by means of a high-temperature centrifugal pump, and after leaving the reactor, went through a heat exchanger (Fig. 4). The heat ultimately was rejected to water. Between the fuel-system heat exchanger and the water heat exchanger, a stream of recirculating high-velocity helium was employed as an intermediate heat-exchanger fluid.

The heat generated in the BeO reflector was removed by circulated sodium; this heat too was rejected to water by means of an intermediate helium system. Because of the thermal expansion of the fuel, the reactor was expected to be entirely self-controlling. The only controls other than the inherent negative temperature coefficient were a stainless-steel regulating rod which ran

through the centre of the reactor, and three boron carbide safety rods.

ARE Dimensions and Data

A right circular cylinder, 33·3 in. in diameter and 35·8 in. high, formed the active region of the reactor. The beryllia reflector was 7·4 in. thick. The critical mass was 14·9 kg. of U235, the total mass of U235 in the core and external system being about 66 kg. The fluorides flowed through the reactor at 1 m. per sec.; the Reynolds number was 10,000.

Although designed to operate at 1,500 kW, the reactor actually ran at a peak output of 2,500 kW. The exit temperature of the fuel from the reactor to the heat exchanger rose to about 1,500 deg. F.; the inlet fuel temperature was about 1,200 deg. F.

Start-Up and Operation

Criticality was achieved on November 3, 1954, by the addition of molten uranium tetrafluoride concentrate to the barren mixture of molten fluoride salts. The reactor went critical essentially without incident and was brought to full power operation on November 9. It ran continuously for about four days and nights, and, after logging more than 90 MWh of high-power high-temperature operation, was shut down. The ARE has since been dismantled.

Results from ARE

Several important observations were made by the laboratories and are listed below.

1. The extreme stability of a liquid-fuel reactor was noted. The reactor was completely power-demand responsive, the control being mainly by manipulation of the flow of cooling helium gas to the heat exchanger. The control rods were used for setting the operating temperature level.

2. Xenon 135 came off continuously, as did many other gaseous fission products.

3. Keeping the pipes always heated so that no freeze-up occurred was shown to be feasible and practical. This problem in the ARE is rather analogous to the problem of maintaining pressure in the aqueous HRT. It is, so to speak, the price one pays for using a fuel that boils at very high temperature.

4. As in the HRT, the problem of maintaining absolute leak tightness was difficult. It was solved adequately for the relatively short period of operation of ARE; however, there was a very small leak from the gas volume above the liquid surface of the fuel pumps. This made the operation awkward during part of the time.

Altogether the experience with ARE reinforced the view of Oak Ridge that chemical reactor systems merit serious investigation, that even a high melting salt mixture can be used as a reactor fuel, and that one way to achieve economic nuclear power—perhaps the simplest way—is to burn U235 in very high-temperature devices like ARE, in which the fuel is liquid. The Oak Ridge National Laboratory hopes to be able to demonstrate not only short-term operability of such devices, but also long-term reliability of components and compatibility of materials for application in central-station molten-fluoride power plants.

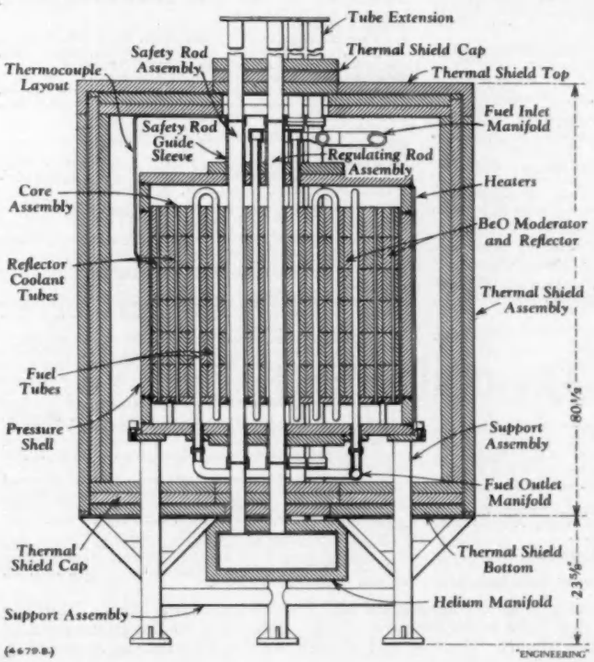


Fig. 3 A vertical section shows the various circuits within the reactor core. Liquid sodium cools the reflector.

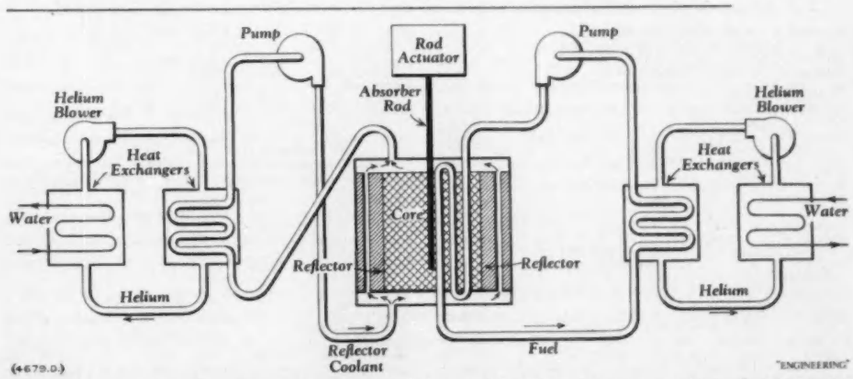


Fig. 4 Between the fuel-system heat exchanger and the water heat exchanger, a stream of recirculating high-velocity helium serves as an intermediate heat-exchanger fluid.

General Notes

Windscale Accident

Comment on the recent Windscale accident (see Atomic Review and Plain Words, October 18) was made by Mr. W. Strath, member of the United Kingdom Atomic Energy Authority for external relations and commercial policy, at the Atomic Industrial Forum Banquet held in New York on October 29. A board of inquiry under Sir William Penney has been studying the accident. Mr. Strath reported that the reactor was not operating at the time. The staff were carrying out a regular maintenance procedure which was required on graphite reactors from time to time, particularly if they operate at low temperature. This is because the irradiation of the graphite leads to a storage of energy in it, the so-called Wigner effect. This energy had to be released periodically by annealing the graphite—by raising its temperature. Some part of the reactor core became overheated—the reasons why this happened would doubtless come out in the board of inquiry's report—and as a result chemical reactions took place between uranium and the air coolant which led to a further rise in temperature. The result of the chemical reaction was that some of the uranium fuel elements were oxidised, and in particular the radioactive iodine fission product was boiled off. The reactor—it was designed some ten years ago—was cooled by air which was exhausted through a high stack into the atmosphere; filters were installed at the top of the stack and these normally stopped 99 per cent. of any radioactive particles which were released. The iodine, however, which had low melting and boiling points, was in gaseous form and a good deal of this passed through the filters and there was some contamination of the surrounding grassland. This in turn was collected by cows and found its way into milk, so that the milk from an area of about 200 square miles had a radioactive iodine content several times higher than that considered safe by the Medical Research Council, at any rate for young children. Deliveries of milk from this area were at once suspended. Radioactive iodine had a half-life of 8 days so that the activity decayed rapidly. This kind of accident could not happen in a power station of the Calder Hall type. The operating temperature of the graphite in these power stations would be higher so that less energy was stored in the graphite and some annealing was going on all the time. Furthermore, the carbon-dioxide coolant used in the Calder Hall reactors was much less chemically reactive than air and from experience it was known that any uranium exposed would react much more slowly. Finally the cooling gas circulated within a closed system so that any fission products released into the coolant would not be sent into the open air.

Nuclear Power Programme

It has been reported that the United Kingdom investment in nuclear power stations is to be cut by about 10 per cent. or £90 million during the period up to December 31, 1965.

U.S. Proposals for Gas-Cooled Reactor

The United States Atomic Energy Commission has received 31 proposals from United States architect-engineering firms to perform the engineering design of a natural-uranium, gas-cooled, graphite-moderated nuclear electric power plant of 40 MW electrical capacity. The proposals were made in response to the Commission's invitation of August 31, 1957. Most of the proposals included the name of sub-contractor firms which would perform the nuclear portion of the design work. A contractor will be chosen on the basis of the recommendations of a Commission selection board which is evaluating the proposals. Development, design and engineer-

Continuing Atomic Review

ing work on this prototype plant has been authorised by the Congress. A report on the design, including cost estimates and schedule of construction, is to be submitted by the Commission to the Joint Committee on Atomic Energy of the Congress by April 1, 1958.

Compact Military Reactor

The United States Atomic Energy Commission is inviting qualified industrial firms to submit proposals for preliminary studies on compact nuclear reactor systems for military use. The purpose of these studies is to determine those nuclear reactor concepts which show most promise for use in military applications demanding a mobile power plant with moderate power rating—up to 2 MW net electric output—extreme compactness, and low operating weight.

Offer to Build German Reactor Withdrawn

Mitchell Engineering, Limited, have announced that they and their United States associates, A.M.F. Atomics Incorporated, have withdrawn their offer to build a 15 MW boiling-water nuclear power plant with a urania-thoria core for the West German company R.W.E. (Rheinisch-Westfälische Elektrizitätswerk). (See Atomic Review, last March 29, April 5 and July 26.) A.M.F. Atomics has been unable to come to financial terms with the U.S.A.E.C. with regard to development of the core. The German firm has asked the consortium (A.M.F.—Mitchell Engineering—Siemens-Schuckert) to submit a new offer based on a proposed alternative core.

Reactor for Japan

The Japanese Ministry of Construction, investigating the Calder Hall type of reactor on behalf of the Japanese Atomic Energy Commission, has concluded that the reactor is not in its present form entirely proof against damage by earthquake. This improvement could be effected at an increase in cost of about 1 per cent. by redesigning. Japan is considering purchase of a Calder Hall type of reactor. Another difficulty has been the British claim that spent fuel should be returned to Britain for processing.

Reactor Safety Conference

Nuclear reactor safety evaluation and research programmes to assure safe design were discussed by speakers representing Government and industry during a Reactor Safety Conference in New York, on October 31, sponsored by the U.S.A.E.C., the American Nuclear Society, and the Atomic Industrial Forum.

Conference on Controlled Thermonuclear Research

Major phases of research in the field of controlled thermonuclear reactions in the United Kingdom and the United States were reported upon and discussed on October 17 and 18 in a joint conference of representatives of the two nations at Princeton University. The conference was arranged by the U.S.A.E.C. and the U.K.A.E.A. The exchange of information was under the agreement for co-operation between the two countries on the civil uses of atomic energy. The last meeting was at Harwell, on June 20.

Atoms for Peace Award

Professor Niels Bohr, the Danish physicist who has made some of the most important contributions to the understanding of the atomic nucleus, has received the first Atoms for Peace Award. The sum of 75,000 dols. was presented to Professor Bohr at a ceremony in Washington on October 24 attended by President Eisenhower. The Atoms for Peace Awards were created by the Ford Motor Company as a memorial to Henry Ford and Edsel Ford. President Eisenhower had called private business and professional men throughout the world to take an interest and provide an incentive in finding new ways that nuclear science can be used . . . for the benefit of mankind and not destruction. The Ford Motor Company Fund authorised an appropriation of one million dols.—to be used at the rate of 100,000 dols. annually for 10 years.

NOTICES OF MEETINGS

Association of Supervising Electrical Engineers

LONDON
"Infra-Red Heating," by H. S. Carter. Central London Branch. White Hall Hotel, Bloomsbury-square, W.C.1. Mon., Nov. 11, 6.30 p.m.
"Electricity Supply to the London Underground System," by H. L. Buckman. South West London Branch. Prince of Wales Hotel, Wimbledon, S.W.19. Thurs., Nov. 14, 7.45 p.m.
BIRMINGHAM
"Light Sources," by G. V. McNeill. Birmingham Branch. Birmingham Exchange and Engineering Centre, Stephenson-place, Birmingham. Wed., Nov. 13, 7.30 p.m.
BRADFORD
"Electric Motor Control and Overload Protection," by S. H. Harding. Bradford Branch. Midland Hotel, Bradford. Wed., Nov. 13, 7.30 p.m.
PORTSMOUTH
"Water Heating Electrically," by L. E. Hughes. Portsmouth Branch. Wiltshire Lamb Hotel, Portsmouth. Tues., Nov. 12, 7.30 p.m.
YORK
"Electrode Boilers," by D. Stretton-Smith. York Branch. Royal Station Hotel, York. Tues., Nov. 12, 7.30 p.m.

British Institution of Radio Engineers

MANCHESTER
"Some Electronic Techniques Used in Textile Research," by J. B. Todd. North Western Section. College of Technology, Sackville-street, Manchester. Thurs., Nov. 14, 6.30 p.m.
WOLVERHAMPTON
"Cold Cathode Switching Techniques," by J. H. Beesley. West Midlands Section. Wolverhampton and Staffordshire Technical College, Wulfruna-street, Wolverhampton. Wed., Nov. 13, 7.15 p.m.

Chemical Society

EDINBURGH
"Biradicals," by Dr. A. F. Trotman-Dickenson. Edinburgh Branch. Royal Society of Edinburgh, 24 George-street, Edinburgh. Thurs., Nov. 14, 7.30 p.m.
ST. ANDREWS
"Seaweeds and Their Utilisation," by Dr. F. N. Woodward. St. Andrews and Dundee Branch. Chemistry Department, St. Salvator's College, St. Andrews. Fri., Nov. 15, 5.15 p.m.

Illuminating Engineering Society

LONDON
"Artificial Lighting for Museums and Art Galleries," by W. E. Rawson-Bottom and J. B. Harris. Science Museum, South Kensington, S.W.7. Tues., Nov. 12, 6 p.m. (Tea at Victoria and Albert Museum, 5 p.m.)
"School Design," by D. L. Medd. Royal Institute of British Architects, Portland-place, W.1. Thurs., Nov. 14, 6 p.m.
SHEFFIELD
Presidential Address, by E. B. Sawyer. Sheffield Centre. Grand Hotel, Sheffield. Mon., Nov. 11, 6.30 p.m.
SUNDERLAND
"Design of Lighting Glassware," by S. S. Beggs. Newcastle-upon-Tyne Centre. Sunderland Technical College, Sunderland. Tues., Nov. 12, 6.15 p.m.

Incorporated Plant Engineers

CHESTER
"Industrial Lubrication," by G. Stott. Merseyside and North Wales Branch. The Blossoms, City-road, Chester. Mon., Nov. 11, 7.15 p.m.
DUNDEE
"Manufacturing Experiences," by J. Lomax. Dundee Branch. Mathers Hotel, Dundee. Mon., Nov. 11, 7.30 p.m.
MANCHESTER
Discussion on "Nuclear Power." Manchester Branch. Engineers' Club, Albert-square, Manchester. Tues., Nov. 12, 7.15 p.m.
NEWCASTLE-UPON-TYNE
"Steel Production by Modern Methods," by G. E. Hemming. North East Branch. Roadway House, Oxford-street, Newcastle-upon-Tyne. Thurs., Nov. 14, 7 p.m.
NOTTINGHAM
"Life of a Factory Inspector in India," by B. W. Glover. East Midlands Branch. County Hotel, Theatre-square, Nottingham. Wed., Nov. 13, 7 p.m.

Institute of Fuel

LIVERPOOL
"Ash and Dust Handling," by J. H. Prole. Merseyside Sub-Section. Liverpool Engineering Society, 9 The Temple, 24 Dale-street, Liverpool. Wed., Nov. 13, 6.30 p.m.
MANCHESTER
One-day conference on "Space Heating without Smoke." North Western Section. Engineers' Club, Albert-square, Manchester. Wed., Nov. 13, 10.30 a.m.

Institute of Marine Engineers

LONDON
"Heat Balance Calculations and Their Use in the Installation Design of Steam Turbine Merchant Ship Propulsion Machinery," by Commander E. Tyrrell, R.N.(ret.). Tues., Nov. 12, 5.30 p.m.*
GLASGOW
"Developments in Marine Electrical Installations, with Particular Reference to Alternating-Current Supply," by A. N. Savage. Scottish Section. Institution of Engineers and Shipbuilders in Scotland, 39 Elmbank-crescent, Glasgow, C.2. Wed., Nov. 13, 7.30 p.m.

Institute of Marine Engineers and Institution of Naval Architects

SOUTHAMPTON
"Cargo Handling and Associated Deck Machinery," by J. West. Southern Joint Branch. Southampton Technical College, St. Mary-street, Southampton. Tues., Nov. 12, 7.30 p.m.

Institute of Metals

LONDON
"Low Temperature Deformation of Metals," by Dr. T. H. Blewitt. Thurs., Nov. 14, 6.30 p.m.
GLASGOW
"Vacuum Metallurgy," by Dr. F. C. Weil. Scottish Local Section. Institution of Engineers and Shipbuilders in Scotland, 39 Elmbank-crescent, Glasgow, C.2. Mon., Nov. 11, 6.30 p.m.
OXFORD
Discussion on "Recent Advances in Iron-Making." Oxford Local Section. Cadena Café, Cornmarket-street, Oxford. Tues., Nov. 12, 7 p.m.
SWANSEA
"Nuclear Power," by L. Rotherham. South Wales Local Section. Royal Institution, Swansea. Tues., Nov. 12, 7 p.m.

Institute of Packaging

LEEDS
"Pilferage and Packaging," by A. H. Moncrieff. Leeds and Bradford Branch. Great Northern Hotel, Leeds 1. Thurs., Nov. 14, 7.30 p.m.

Institute of Physics

LONDON
"Crossed Field Interaction in Microwave Valves," by W. E. Willshaw. Electronics Group. Tues., Nov. 12, 5.30 p.m.*
BANGOR
"Polar Wandering and Continental Drift," by Professor S. K. Runcorn. Liverpool and North Wales Branch. Physics Department, University College of North Wales, Bangor. Thurs., Nov. 14, 5.45 p.m.*
BIRMINGHAM
"Time Measurement," by Dr. F. A. B. Ward. Midland Branch. Birmingham Exchange and Engineering Centre, Stephenson-place, Birmingham. Thurs., Nov. 14, 7 p.m.
SWANSEA
"Atomic Clock," by Dr. L. Essen. South Wales Branch. Physics Department, University College, Swansea. Fri., Nov. 15, 5.15 p.m.

Institution of Chemical Engineers

BIRMINGHAM
"Fibre Reinforced Plastics in the Chemical Industry," by F. F. Jaray. Midlands Branch. Midland Institute, Paradise-street, Birmingham. Wed., Nov. 13, 6.30 p.m.

Institution of Civil Engineers

LONDON
"Plastic Design of Pitched Roof Portal Frames," by Jacques Heyman. Tues., Nov. 12, 5.30 p.m.*

Institution of Electrical Engineers

LONDON
Discussion on "Ought Electricity to be Used for Space Heating in Domestic Premises?" opened by D. J. Bolton. Mon., Nov. 11, 5.30 p.m.*
"Broad-Band Slot-Coupled Microstrip Directional Couplers," "The Application of Printed-Circuit Techniques to the Design of Components," and "Re-Entrant Transmission Line Filter Using Printed Conductors," by J. M. C. Dukes. Radio and Telecommunication Section. Wed., Nov. 13, 5.30 p.m.*
"Direct-Current Winder Drives Using Mercury-Arc Rectifier/Inverters," by L. Abram, J. B. McBreen and J. Sherlock. Utilization Section. Thurs., Nov. 14, 5.30 p.m.*
"Manufacture of Electric Cables," by J. D. Navey. London Graduate and Student Section. Tues., Nov. 12, 6.30 p.m.*
BELFAST
"Choice of Insulation and Surge Protection of Overhead Transmission Lines of 33 kV and Above," by A. Morris Thomas and D. F. Oakeshott. Northern Ireland Centre. Queen's University, Belfast. Tues., Nov. 12, 6.30 p.m.
BIRMINGHAM
"Some Engineering Problems in the Industrial Development of Nuclear Energy," by Sir Claude Gibb. South Midland Centre. Midland Institute, Birmingham. Thurs., Nov. 14, 6 p.m. (Admission by ticket.)

The address and telephone number of the headquarters of each institution are given below. Meetings in the headquarters town are held there unless otherwise stated. Particulars for this column should reach the Editor not later than Monday morning in the week preceding the date of the meeting.

* An asterisk is placed where it is understood that tea is available prior to the time stated.

Association of Supervising Electrical Engineers, 23 Bloomsbury-square, London, W.C.1. (LANgham 5927.)
British Institution of Radio Engineers, 9 Bedford-square, London, W.C.1. (MUSeum 1901.)
Chemical Society, Burlington House, Piccadilly, London, W.1. (REGent 0675.)
Illuminating Engineering Society, 32 Victoria-street, London, S.W.1. (ABBey 5215.)
Incorporated Plant Engineers, 12 The Parade, Solihull, Warwickshire. (Solihull 1111.)
Institute of Fuel, 18 Devonshire-street. Portland-place, London, W.1. (LANgham 7124.)
Institute of Marine Engineers, Memorial Building, 76 Mark-lane, London, E.C.3. (ROYal 8493.)
Institute of Metals, 17 Belgrave-square, London, S.W.1. (BELgravia 3291.)
Institute of Packaging, Apply to Mr. H. Williams, 80 Lancaster-avenue, London, S.E.27. (GIPsy Hill 4859.)
Institute of Physics, 47 Belgrave-square, London, S.W.1. (BELgravia 6111.)
Institution of Chemical Engineers, 16 Belgrave-square, London, S.W.1. (BELgravia 3647.)
Institution of Civil Engineers, Great George-street, London, S.W.1. (WHItehall 4577.)
Institution of Electrical Engineers, Savoy-place, Victoria-embankment, London, W.C.2. (TEMple Bar 7676.)
Institution of Heating and Ventilating Engineers, 49 Cadogan-square, London, S.W.1. (SLOane 3158.)
Institution of Mechanical Engineers, 1 Birdcage-walk, St. James's Park, London, S.W.1. (WHItehall 7476.)
Institution of Naval Architects, 10 Upper Belgrave-street, London, S.W.1. (SLOane 4622.)
Institution of Production Engineers, 10 Chesterfield-street, London, W.1. (GROsvenor 5254.)
Junior Institution of Engineers, Pepys House, 14 Rochester-row, London, S.W.1. (VICtoria 0786.)
Manchester Association of Engineers, 18 Booth-street, Manchester 2. (Central 1717.)
Newcomen Society, Science Museum, Exhibition-road, London, S.W.7. (KENsington 1793.)
North East Coast Institution of Engineers and Shipbuilders, Bolbec Hall, Newcastle-upon-Tyne 1. (Newcastle 20289.)
Pipeline Industries Guild, 7 Iddesleigh House, Caxton-street, London, S.W.1. (ABBey 6925.)
Reinforced Concrete Association, 94–98 Petty France, London, S.W.1. (ABBey 4504.)
Royal Aeronautical Society, 4 Hamilton-place, London, W.1. (GROsvenor 3515.)
Royal Society, Burlington House, Piccadilly, London, W.1. (REGent 3335.)
Royal Statistical Society, 21 Bentinck-street, London, W.1. (WELbeck 7638.)
Royal United Service Institution, Whitehall, London, S.W.1. (WHItehall 5854.)
Sheffield Metallurgical Association, 66 Ringstead-crescent, Sheffield, 10. (Sheffield 62144.)
Society of Instrument Technology, 20 Queen Anne-street, London, W.1. (LANgham 4251.)
West of Scotland Iron and Steel Institute, 39 Elmbank-crescent, Glasgow, C.2. (Central 5181.)

BRISTOL
"Electrical Floor Warming," by J. W. Moule and W. M. Stevenson. Western Centre. Offices of the South Western Electricity Board, Bristol. Mon., Nov. 11, 6 p.m.*
NEWCASTLE-UPON-TYNE
"Cathodic Protection," by L. B. Hobgen, K. A. Spencer and P. W. Heselgrave. North Eastern Centre. Neville Hall, Westgate-road, Newcastle-upon-Tyne. Mon., Nov. 11, 6.15 p.m.

Institution of Heating and Ventilating Engineers

BIRMINGHAM
"Ventilating Problems in the Atomic Energy Industry," by Dr. C. N. Davies. Birmingham Branch. Birmingham Exchange and Engineering Centre, Stephenson-place, Birmingham. Tues., Nov. 12, 6.30 p.m.
MANCHESTER
Discussion on "The Industrial Application of Nuclear Energy." Manchester Branch. Engineers' Club, Albert-square, Manchester. Tues., Nov. 12, 7.15 p.m.

Institution of Mechanical Engineers

LONDON
"Suspension of Internal-Combustion Engines in Vehicles," by M. Horovitz. Automobile Division. Tues., Nov. 12, 6 p.m.*
Corporate members' meeting to consider new by-laws. Wed., Nov. 13, 6 p.m. (Tea at 6.15 p.m.)
Discussion on "Steam Conditions in Relation to the Size of Units." Steam Group. Wed., Nov. 13, 6.45 p.m.*
Thomas Hawksley Lecture on "Vibration: A Survey of Industrial Applications," by Professor J. P. den Hartog. Fri., Nov. 15, 6 p.m.*
ABERDEEN
"Recent Developments in Propulsion Machinery and Refrigeration Equipment for Deep Sea Trawlers," by G. C. Eddie. Scottish Branch. Robert Gordon's College, Aberdeen. Fri., Nov. 15, 7.30 p.m.
CHELMSFORD
"World's Largest Walking Dragline Excavator," by C. McL. Cameron. Eastern Branch. Hofmann Hall, Chelmsford. Thurs., Nov. 14, 7.30 p.m.
LEEDS
"Design of Bolted Flanged Joints of Pressure Vessels," by G. F. Lake and G. Boyd. Yorkshire Branch. Chemistry Lecture Theatre, The University, Leeds. Thurs., Nov. 14, 6.30 p.m.
SWANSEA
"Application of Computers to the Control of Machine Tools," by Dr. D. Rogers (with film). South Wales Branch. Offices of the South Wales Electricity Board, Kingsway, Swansea. Tues., Nov. 12, 6 p.m.

Institution of Production Engineers

LONDON
"Paper Production," by I. Hendry. Royal Empire Society, Northumberland-avenue, W.C.2. Thurs., Nov. 14, 7.15 p.m.
DORKING
"European Free Trade: A Challenge to Industry." Eighth London Graduate Section's Weekend School. Opening of the School by G. R. Blakely; "European Free Trade: Proposals and Prospects," by Austen Albu; and "The Contribution of the Economist in Industry," by Nicholas A. H. Stacey, Sat., Nov. 16, 12 noon and 5 p.m. "The Responsibility of the Production Engineer," by Bernard E. Stokes; General Discussion; and "A Summary of the School," by Dr. F. A. Freeth, Sun., Nov. 17, 10 a.m. and 2 p.m. Beatrice Webb House, Holmbury St. Mary, near Dorking.
LEEDS
"Development of Rubber in Engineering," by E. S. Kendall. Leeds Section. Hotel Metropole, Leeds. Mon., Nov. 11, 7 p.m.
OXFORD
"People in Industry," by E. W. Hancock. Oxford Section. Town Hall, Oxford. Tues., Nov. 12, 7.30 p.m.
SHEFFIELD
"Spark Erosion Process," by L. Adcock. Sheffield Section. Grand Hotel, Sheffield. Mon., Nov. 11, 6.30 p.m.

Junior Institution of Engineers

LONDON
Chairman's Address "Some Aspects of Town Gas Distribution," by J. E. Gray. Fri., Nov. 15, 7 p.m.*

Manchester Association of Engineers

MANCHESTER
"The Runcorn-Widnes Bridge," by J. Kenneth Anderson. Engineers' Club, Albert-square, Manchester. Fri., Nov. 15, 6.45 p.m.

Newcomen Society

LONDON
Annual General Meeting. "The Structural Use of Iron in Antiquity," by Dr. S. B. Hamilton. Science Museum, South Kensington, S.W.7. Wed., Nov. 13, 5.30 p.m.

North East Coast Institution of Engineers and Shipbuilders

NEWCASTLE-UPON-TYNE
"Standardisation of Large Oil Tankers," by N. Carter. Mining Institute, Newcastle-upon-Tyne. Fri., Nov. 15, 6.15 p.m.*

Pipeline Industries Guild

LONDON
"Pipeline Weld Inspection," by G. A. K. Stobie and J. J. Maye. Caxton Hall, off Victoria-street, S.W.1. Tues., Nov. 12, 6.30 p.m.

Reinforced Concrete Association

LONDON
"Production and Quality Control of Sand and Gravel Aggregates," by B. L. Morton. 11 Upper Belgrave-street, S.W.1. Wed., Nov. 13, 6 p.m.*

Royal Aeronautical Society

LONDON
"Some Problems of Stability and Control," by H. H. B. M. Thomas. Tues., Nov. 12, 7 p.m.

Royal Society

LONDON
Discussion on "The Physics and Chemistry of Water," opened by Professor J. D. Bernal. Thurs., Nov. 14, 10.30 a.m.

Royal Statistical Society

NEWCASTLE-UPON-TYNE
"Productivity Measurement at the Plant Level," by Dr. T. E. Easterfield. North Eastern Industrial Applications Group. Armstrong Buildings, King's College, Newcastle-upon-Tyne. Wed., Nov. 13, 7 p.m.

Royal United Service Institution

LONDON
"The Aircraft Designer's Dilemma," by Dr. G. V. Lachmann. Wed., Nov. 13, 3 p.m.

Sheffield Metallurgical Association

SHEFFIELD
"Metallurgical Problems in the Production of Cast Steels," by W. J. Jackson. B.I.S.R.A. Laboratories, Hoyle-street, Sheffield. Tues., Nov. 12, 7 p.m.

Society of Instrument Technology

LONDON
"A Digital Plotting Table," by J. Morrison. Manson House, 26 Portland-place, W.1. Thurs., Nov. 14, 7 p.m.*
MANCHESTER
"Smog," by Dr. E. T. Wilkins. Manchester Section. Manchester College of Technology, Manchester. Tues., Nov. 12, 7.30 p.m.

West of Scotland Iron and Steel Institute

GLASGOW
"Work Study in the Iron and Steel Works" by Paul Hanika and E. Glen. Fri., Nov. 15, 6.45 p.m.

In Parliament

A NEW SESSION COMMENCES

The two Houses of Parliament, which both resumed their sittings on October 29, after a vacation lasting since August 2, were duly prorogued on November 1, and a new session, the third session of the present Parliament, was opened by the Queen on Tuesday last.

In her prorogation speech Her Majesty referred briefly to some of the more important business transacted during the session then ending, mentioning, in particular, the provision that had been made for the re-organisation of the electricity industry in England and Wales, the Act for extending the right of redress for damage caused by subsidence resulting from coal mining, and the measure for permitting the imposition of countervailing and anti-dumping duties on goods imported into the United Kingdom.

Provision had been made, Her Majesty stated, for more effective long-term assurances to agriculture and for assistance towards the modernisation of farms in the United Kingdom, as well as for aiding the modernisation of the country's fishing fleets. The Government had also approved the re-organisation and expansion of this country's information services overseas.

On the question of the international exchange of scientific information and of securing a much closer collaboration in that field between the various countries of the West, Mr. Harold Macmillan, the Prime Minister, informed the Commons that, during the visit of the Foreign Secretary and himself to Canada and the United States, a Declaration of Common Purpose had been issued jointly by the President of the United States and Mr. Macmillan. It was the purpose of the declaration to secure the participation of the allies of Britain and the United States in a common partnership, whereby the resources of these countries could most effectively be used in the interests of them all. Britain and the United States would urge in the North Atlantic Treaty Organisation that there should be an increase of scientific research and development in support of greater collective security.

The President of the United States would request Congress to amend their Atomic Energy Act as might be necessary and desirable. For their part, the Canadian Government had expressed themselves as being most ready to subscribe to the principle of interdependence and to join in the common effort necessary to make it effective. There already existed a full exchange of information between Britain and the United States on the peaceful uses of atomic energy. The Declaration would extend that co-operation and make it more fruitful.

INVESTMENTS IN INDUSTRY

The principal debate in the Commons prior to the prorogation dealt with Britain's economic situation. It was opened by Mr. Peter Thorneycroft, the Chancellor of the Exchequer, who affirmed that the recent measures taken by the Government to combat inflation had been wise and prudent ones. They had resulted in the immediate strengthening of the international exchange markets in favour of sterling. One sign of this renewal of confidence was that the exchange with the United States, which had been maintained at a parity of 2·80 dols. to the pound for the last eight years, had been kept at that level. It was in the interests of the whole country that the exchange should remain at that level, and the Government intended that it should so remain.

One result of the existing financial stringency was that capital investments had had to be carefully examined. The Government intended to devote to capital resources £1,500 million in 1958-59 and a like amount in 1959-60, which represented a formidable rate of advance, but the investments of all public authorities in Great Britain would be limited to those total amounts. The nationalised industries drew heavily upon the taxpayers for their capital resources and in connection with the power sector—electricity, coal and gas—the Government intended to spend about £450 million on improvements next year, and some £480 million in the following year.

In the coal industry, the Government would spend £110 million next year and £120 million the year after. Thereby, the National Coal Board would be enabled to complete 40 major colliery development and modernisation schemes, to continue about 100, and to start about 60 more during the period. The Government would spend £100 million during the next two years on roads. On the services of the British Transport Commission, the Government would be investing around £170 million in each of the next two years. Capital investment in the Post Office had been rising towards the £100 million mark, and it would be fixed at £95 million next year and at £90 million in the following year.

The Government did not intend to finance inflation, but the total expenditure of £1,500 million a year represented an increase of 37 per cent. in real terms on that for 1951.

BRAKE ON WAGES AND PROFITS

Turning to wages and profits, Mr. Thorneycroft said that the Government's object was to secure that increases under both heads should be harder to obtain. Restraint in the distribution of profits would assist the national purpose. With respect to wages, he considered that the Government should state their view of the economic situation with absolute clarity and where they considered the national interest to lie. By their monetary, fiscal and spending policies they should create an economic climate consistent with that view, they should not interfere with collective bargaining and, where they were themselves the employers, they should seek to follow the policies that they urged upon others.

If wage increases continued to be granted on the same scale as in the past, and as they were now being granted, the country would face disaster. Increases unrelated to the general growth of real wealth in the country were by far the greatest danger that had to be faced. Work-people who asked for higher wages, people who granted such increases and those who adjudicated regarding them should have this fact firmly fixed in the forefront of their minds. Any large mistake at this stage by any of these groups could do grievous damage to the nation as a whole.

The measures which the Government had taken would be applied with determination and would operate over a wide area. If costs, including wage costs, went up, activity would have to be reduced and that course would be the policy where the Government was looked to as the source of cash. These remarks applied, for example, to the case of the British Transport Commission, where the Government were providing the finances to meet the railway deficit.

Naturally, the Government did not operate over the whole field and, in a free society, they could not control individual judgments. In this context, it was of the utmost value that the Council on Productivity, Prices and Incomes had begun its work. Its impartial advice would help to secure the responsible approach essential to success.

The Human Element

Fitting In with Technical Growth

A new series of pamphlets called *Problems of Progress in Industry* is being issued by the Department of Scientific and Industrial Research, price 2*s*. each. The first of these is now available called *Men, Steel and Technical Change*. It is based on a study entitled *Technical Change and Industrial Relations*, published by the Liverpool University Press in 1956 at 17*s*. 6*d*. and is a simplified and shortened version of that report.

The pamphlet is a case study in a large steel works of the impact on human relations of two major technical changes over the last twenty years. Since it deals with the steel industry, the study is examining a company which has enjoyed a rising demand for its products over those years and which has experienced high capital (as compared with labour) costs and good relations with the trade and craft unions, the latter being particularly important in steel. All these aid in solving the human problems of technical change.

These changes were successfully carried through both from the technical and labour point of view. So far as the latter is concerned, this was possible because management and organised labour respected each other and agreed on each other's sphere of influence. In particular, shop stewards had much power and used it constructively. Prior consultation on technical changes and agreed schemes of compensation for redundancy were found to be important. This is only a sketch of the issues raised in the pamphlet but it shows that first-hand experience reinforces much good textbook generalisation. The series will repay study by those with human relations problems to handle and who are too busy to read the original studies.

The Cost of Leisure

The unions' campaign for a 40-hour week, more paid annual leave and less overtime has evoked a rather less than favourable reaction from the employers. In a statement last week-end, the British Employers' Confederation pointed out that the adoption of the 40-hour week alone would add at least £1,000 million to the national wages bill, and was equivalent to an increase of 10 per cent. in hourly wages.

The Confederation said that the reduction of the standard week to 40 hours would mean approximately eight hours overtime a week at an overtime rate based on the increased hourly rate. "The total effect of these increases in hourly rates and overtime pay would be to increase manufacturing costs by approximately 2*s*. 6*d*. in the pound, with corresponding increases to the consumer."

But the unions' main basis for the claim is the anticipation of much less work in 6 to 12 months' time. It is an attempt to keep up earnings as the hours worked tend to fall. Unfortunately this may not happen and more overtime may simply have to be worked. In this case the Confederation's warning would be more than justified, and the higher costs would not be slow in bringing about the unemployment the unions fear. With the movement towards free trade taking shape and gathering momentum, the policy of less hours with the same pay must be an expensive one.

A Kick from the Horse

The Sheffield district committee of the Amalgamated Engineering Union last week hit out in defence of union practice and privilege. The committee "fined" five members £1 each and severely censured them because they had asked their employers, Ambrose Shardlow Limited, of Meadow Hall, Sheffield, if they could be allowed to work an extra five hours a week.

The comment of Mr. H. Ulyatt, district secretary of the A.E.U., was that "any recurrence of an attitude of that character by the five men will be severely dealt with. They have violated rule 22, clause 1, of the union by acting against the best interests of the members. The charge against them was proved, and the men admitted they were wrong in doing what they did."

The company had been working a regular 39-hour week since the Suez crisis. They advertised for more workers. The offenders saw this, asked a shop steward to approach the management to request that they should be allowed to work the standard 44-hour week before men were recruited. He refused, whereupon they did the job themselves. Union procedure is sacred, and the men's action may well have seemed tactless in the present context of the union's policy for a shorter working week.

Telling the Workers

One of the most important developments in management-labour relations, and one in which there seems to be only slow progress, is the need to take the workers into management's confidence and tell them about forward planning and financial results. Yet these are the hallmarks of successful management. Wherever workers are taken into confidence ahead of any decisions which affect their welfare and where they have financial results explained to them, a basis of mutual respect has been formed.

The latest call for more co-operation on these lines has come from the Minister of Labour. He told a lunch meeting in London of the Institution of Works Managers last week that it was necessary to build up a day-to-day contact with the workers which would include informing them about plans currently maturing which would affect them.

It is sometimes said that there is no great demand by workers to see financial results set out in a form to interest them or for foreknowledge about schemes likely to affect their interests. To some extent this lack of interest is the result of lack of communication in the past. In the past, knowledge has been replaced by prejudice and this last takes a good deal of patient human-relations work to remove. When it has been done management may find that organised labour has a contribution to make in the way of constructive criticism.

The First Ditch

The decision of the Minister of Health to set aside the Whitley Council award to health service officers will not make much of an impact on the problem of wage inflation but it will certainly inflate the anger of the trade unions as a whole. It has nothing to recommend it in terms of organised wage negotiation but a good deal to support it in terms of shock treatment and the Government applying its own principles.

The unions as a whole are given clear warning well in advance that they had better look out their face-saving machinery and dust it over before the winter. They are warned that so far as the Government is concerned, they may well need it. Bit by bit the Government is showing its hand for the coming wage battle. In another note, dealing with transport demands, attention is drawn to the Government's policy on wage increases for the nationalised industries and it has already advised arbitration tribunals to take a firmer line. This last move looks like pressure to the trade unions but it is to be expected at a time like this when economic pressure on the economy is growing and there is no body of "case law" on which arbitrators may rely for precedents. The days of more or less automatic increases in wages, blithely passed on by employers to customers, are numbered.

Upon their own Heads

The nationalised industries now know what lies in store for them this winter. The Government will keep as far away from the wages struggle as possible, and let the Boards find their own solutions—provided they find their own money. The Chancellor's statement on the railway workers' claim could not have been more definite: "It must be clearly and absolutely understood," said Mr. Thorneycroft, "that the Government will not extend assistance to the Commission beyond what it has already undertaken." In simple language, this means that the Commission will not be able to grant even the smallest increase unless their earnings allow it. There will be no increased borrowing, either from the public or from public funds.

But there are several ways out of this difficulty: one is to find the money out of the customer's pocket and simply raise charges to buy industrial peace. This has been done before, but the Commission are finding that demand for their services tends to be affected by the fares and freight levels they charge. Also, the Government will obviously discourage such a course although they are now committed to a policy of standing aloof and of "no war upon the unions." Another way out is simply to stand firm and, when trouble comes, to refer it back to the Minister of Transport. In this respect, Mr. MacLeod, Minister of Labour, was explicit that "if after the processes of bargaining have been completed serious industrial trouble still comes, the Government will not hesitate to meet that situation."

There is much that the Government can do or influence, as their recent action in respect of the health service pay award and the implied warning to wages tribunals has shown. But a "total stand" has a melodramatic flavour not quite in keeping with reality, even less with political realism. It is ominous that two of the largest firms in the country should have prepared a sales forecast for the next year "on the assumption that major industrial troubles will recur."

Germans to the Rescue

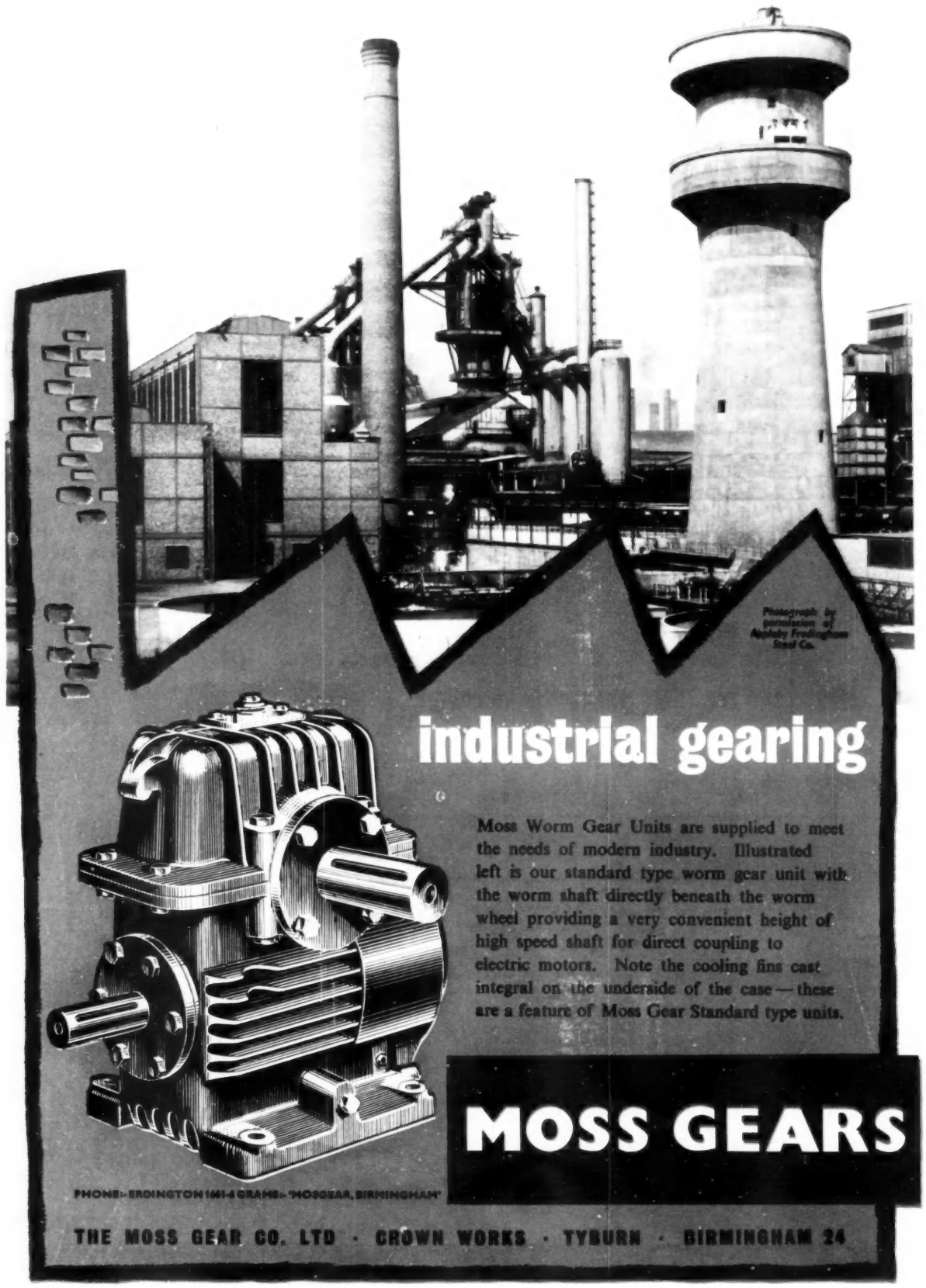
There is yet hope that the German unions will make the task of the British Government a little easier in their stand against higher wages. The main arguments put forward by Mr. Thorneycroft, Mr. MacLeod and others is that increases mean a reduced ability to compete in export markets and therefore bankruptcy for Britain. But our main competitors are the United States—where wages are mostly tied to the cost of living with a fixed margin for "real" advances—and Germany.

The chairman of the Federation of German Industries announced last week that wage demands now being negotiated or about to be submitted amount to an annual DM 10,000 million (about £850 million). This is not far from the sum mentioned by the Confederation of British Employers as the likely cost of the 40-hour week. But will the German workers wrest as much from their employers as their British brothers? Dr. Fritz Berg, the chairman of the F.G.I. said: "an additional purchasing power of DM 10,000 million if compared with the present payroll of DM 93,000 million, would entail most serious consequences for the stability of Germany's price structure." He warned workers that several industries have already ceased to be in a position to pass on wage increases to the public, and that any rises would imply the risk of redundancy for the industries concerned.

It is the kind of tough realism one would expect from such a quarter, but who's bluffing who?

ENGINEERING

An Illustrated Weekly Journal



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